THE EXPLOSIVES ENGINEER

Forerunner of Progress in
Mining, Quarrying, Construction

CONTENTS

ISAAC NEWTON BAYLESS—*a biography* 68

ISAAC NEWTON BAYLESS—*a photograph* 69

Editorial 70

The Union Pacific Coal Company,
One of America's Great Mining Operations 71
By MONTGOMERY R. BUDD

This issue of THE EXPLOSIVES ENGINEER is devoted entirely to The Union Pacific Coal Company. Even an entire issue falls far short of presenting a complete picture of the complex operations of Union Pacific Coal.

First of all, The Union Pacific Coal Company and THE EXPLOSIVES ENGINEER are not strangers. For many years, Theodore Marvin, director of THE EXPLOSIVES ENGINEER, has presented the Sentinels of Safety trophies to The Union Pacific Coal Company at appropriate exercises in Rock Springs for the 13 years that U.P. has won the National Safety Competition. Thus was founded a close association with I. N. Bayless, now president of The Union Pacific Coal Company. From this association came the concept for the all-embracing article on mining practices.

In effect, the material was written by The Union Pacific staff. To each staff member was delegated authority to prepare data about the workings of his department. In particular, I. M. Charles, chief engineer, Joe Berta, planning engineer, Frank Peternell, safety engineer, and Harry Tibbs, personnel manager, devoted much time and study to the project under the guidance of Vernon O. Murray, vice president, and J. B. Hughes, general manager.

Augmenting this group were Mr. Bayless himself with a watchful editorial eye, William A. Coons, chief photographer of the Union Pacific Railroad Company, and Stanley Kershaw, photographer, of Wapiti, Wyoming, the first safety engineer for Hercules Powder Company.

Blasting and explosives details were reviewed by B. H. Ludwig, sales-serviceman of Salt Lake City office, Hercules Powder Company.

Unfortunately, it is impossible to cover all the various ramifications and functions of a self-contained organization such as The Union Pacific Coal Company, with its water system, power plant, stores, and other important but incidental operating groups, in an article of this type. Yet, these utilities are necessary to make conditions attractive for the inhabitants of a coal-mining community.

The actual visit to the operations was made February 25, 1952, when the temperature at Rock Springs was 15 degrees below zero. The low temperature and the accompanying snow, however, did not deter The Union Pacific Coal Company staff from conducting an outdoor reconnaissance and to point out geological and operating details.

We acknowledge our gratitude, therefore, to those who cooperated so generously in time and effort to bring together some sort of order in this presentation. By name they comprise the staff; by number they comprise the entire organization.

For purposes of the record, the staff members and their duties are listed herewith: I. N. Bayless, president; V. O. Murray, vice president, operations; J. B. Hughes, general manager; Charles Grosso, general superintendent; I. M. Charles, chief engineer; Joseph Q. Berta, planning engineer; K. E. Darling, general manager, Southern Wyoming Utilities Company; E. T. Baldridge, auditor; F. J. Peternell, safety engineer; A. L. Hansen, chief clerk; E. R. Jefferis, manager of stores; J. D. Foster, assistant treasurer; Robert A. Dodds, purchasing agent; H. M. Tibbs, personnel manager; William Wilkes, mine superintendent, Rock Springs; Lawrence Welsh, mine superintendent, Reliance; J. T. Watson, mine superintendent, Stansbury; James Law, mine superintendent, Winton; Tony Taucher, Jr., mine superintendent, Superior; Hodge Burress, mine superintendent, Hanna; Urban F. Toucher, general chief electrician and master mechanic; and Morgan F. Roberts, power plant superintendent.

EDITORIAL STAFF: JOSEPH I. HORTY, *Managing Editor;* ELIZABETH M. JOYCE, *Assistant Editor;* GERTRUDE A. DONNELLY, *Assistant Editor;* EDWARD L. GRANT, *Art Editor;* FRANK J. CANOVA, *Production Manager;* CHARLES E. RABENOLD, *Advertising Manager;* THEODORE MARVIN, *Director;* MONTGOMERY R. BUDD, *Associate Director.*

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BUCYRUS-ERIE COMPANY
South Milwaukee, Wisconsin

Isaac Newton Bayless

PRESIDENT

THE UNION PACIFIC COAL COMPANY

A Biography

Almost from the day he was born, near the coal-mining center of southern Illinois, Isaac Newton Bayless, the son of Clark S. and Sally Ann (Spires) Bayless, decided that he would make coal mining his career and that he would do his best to make coal mining more attractive to miners. That was quite a large order for a youngster who had to piece out his early education with night-school studies and correspondence courses. But I. N. Bayless has been successful, not only in his personal career, but also in his ambition to improve the conditions under which men mine coal.

As president of The Union Pacific Coal Company, Mr. Bayless stands high in the coal industry, and the thirteen victories in the National Safety Competition by mines under his direction are proof of fulfillment of his boyhood ambitions. He would hasten to say that these accomplishments were not made alone, rather he would point out that "safety embraces every employe, not only miners, but all other workers and members of their families, the supervisory staff and management, including the president."

Mr. Bayless started his coal-mining career at nineteen in the underground mines near Marion, Illinois. Through hard, difficult years, he worked up from laborer, mule driver, coal loader, locomotive operator, fire boss, assistant foreman, until finally advanced to mine foreman in 1914.

In the next five years he served as mine manager and general superintendent in various mines in Illinois, West Virginia, and Kentucky. It was during World War I, and after he had served a short time in the 309th Engineers at Camp Taylor, Kentucky, that he noted the demands for coal production often seemed to exclude efficiency and safety in underground mines. Realizing that both objectives could be achieved by good management, he began coordinating safety and efficiency, with the result that, at the close of the war, he was made general superintendent of Union Colliery Company at Dowell, Illinois.

During the next eight years, the industry often heard about Mr. Bayless' improvements in operating efficiency, and his success in developing and fully mechanizing a mine to produce 5,000 tons of coal a day. He early realized that modifications in mining systems, as well as the use of mechanical appliances, were necessary to make mechanization successful, and that unit organization should be teamed with concentrated supervision for safety and efficiency.

From the West, with its difficult coal-mining problems caused by heavy cover and pitching seams, came a demand for his services. So, early in 1927, he accepted the position of general superintendent and assistant to the president of the Utah Fuel Company in Utah, and of the associated Calumet Fuel Company in Colorado.

The Union Pacific Coal Company at Rock Springs had similar mining problems, and in 1929, Mr. Bayless was given a free hand to develop a program for Union Pacific operations with the objective of improving safety and efficiency. From assistant general manager, he rose to general manager in 1936, and to the presidency of the company in 1944.

From the start, Mr. Bayless and his operating and safety staffs conceived, developed, and put into effect far-reaching programs of mechanization and accident prevention. Modernization of equipment and plants has been continued until, today, the "U.P." properties are examples of the best in coal-mining practices.

Although officially located in the general offices of the railroad company at Omaha, Nebraska, Mr. Bayless "commutes" to Rock Springs, Wyoming, on his several duties as president of The Union Pacific Coal Company, Southern Wyoming Utilities Company, and Union Pacific Water Company, and as a special representative of the president of Union Pacific Railroad Company.

While there are extensive demands on Mr. Bayless for his time elsewhere than in Omaha, there is a persistent clamor for him to resist them and to stay close to his home where he lives with his wife, the former Rose Marie Breher, and his four young sons, Isaac Newton, Francis Vernon, Richard Breher, and David Joseph. That quartet keeps him busy solving personnel relations problems, and causes him to thank his lucky star that he has had years of experience in a man's world.

Mr. Bayless is a member of the American Institute of Mining and Metallurgical Engineers, of the American Mining Congress, the Illinois Coal Mining Institute, and the Rocky Mountain Coal Mining Institute. He is a Baptist and a long-time member of the Masons; also an enthusiastic supporter of Boy and Girl Scouts. Ask Mr. Bayless what his hobbies are, and he will likely answer: "BOYS—and coal mining." Dove-tailed into these allegiances, it should be added that Mr. Bayless is an ardent trout fisherman, especially adept at trolling in Wyoming's Jackson Hole lakes. He also qualifies as an enthusiastic guide in the wide-open spaces, especially when he is accompanied by the four young Baylesses.

ISAAC NEWTON BAYLESS

An Editorial Precedent

FOR the first time in our editorial career, we have devoted an entire issue of THE EXPLOSIVES ENGINEER to a single subject or operation.

The cause of this precedent-breaking procedure is the outstanding and almost unique safety operations of The Union Pacific Coal Company. So insistent is the demand of other mines for the "inside" of the consistently successful achievements of "U.P." that we have tried to describe the workings of mines and minds primarily from a safety viewpoint. To understand the underlying success of the safety program requires further understanding of the difficulties of the mining operation.

Hence this special issue on the mines of The Union Pacific Coal Company.

We hope that this presentation will be helpful in inspiring other mines to re-examine their own operating and safety programs to the end that accidents in the entire mining industry will be continually reduced and eventually eliminated.

NO MIRACLES AT ROCK SPRINGS

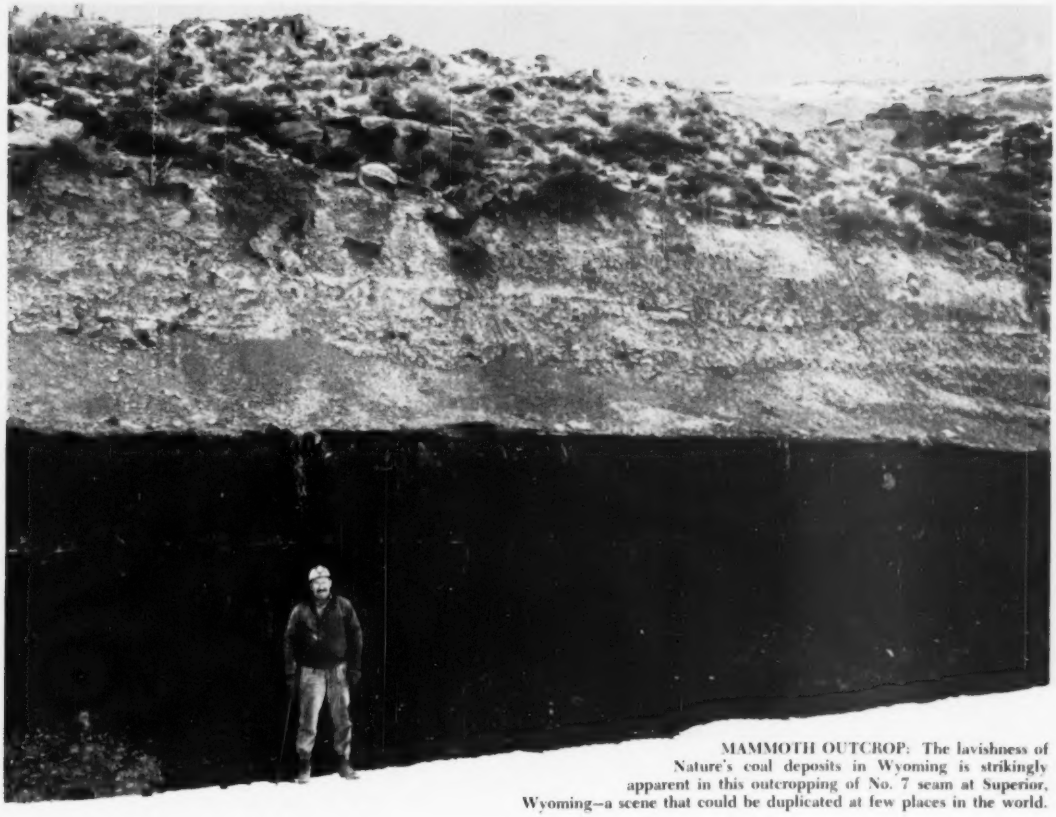
WHY has The Union Pacific Coal Company won 13 of the 27 Sentinels of Safety trophies in the bituminous-coal mines classification of the National Safety Competition? The answer is simple in itself—*organization*. But complicated is the *implementing* of that organization to imbue it with the enthusiasm that must of necessity reach every employe of the Wyoming operations.

We refer you to pages 94 and 96 for a resumé of the stark truth of the safety program at U.P. There you will find a list and description of each accident during 1951, three of which were fatal. You will find, too, that each accident is described in detail and that the management is concerned, not merely with statistics as such, but with the contributing factors and human aspects of each lost-time injury. Only in this way can management probe to determine the *cause* of each accident and take corrective steps to prevent its recurrence.

So this establishes the fact that accidents *do* happen at U.P. and it also establishes the fact that it is possible for some of the mines to run an entire year (and longer) without a solitary mishap. This is the reward of vigilance; this is the reward of organization; this is the reward of individual education; and, finally, it is the reward of recognition of the individual as an individual and as an enthusiastic member of the entire team.

Miracles don't happen at Rock Springs and Hanna. Miracles couldn't guide these coal miners year after year through their steeply pitching workings, their laminated roofs, or their multiple-seam mining. Miracles couldn't keep them accident-free in handling and using heavy equipment, explosives, and electric machinery in the 100 per cent mechanized operations of the mines.

No, the only miracle at Union Pacific Coal is the miracle of organization. The will and the ability to master natural coal-mining difficulties—to overcome more-than-usual hazards—stem from a deep-seated understanding of each miner, fortified with an intense desire to make the individual feel that he is king in the coal-mining program of The Union Pacific Coal Company.



MAMMOTH OUTCROP: The lavishness of Nature's coal deposits in Wyoming is strikingly apparent in this outcropping of No. 7 seam at Superior, Wyoming—a scene that could be duplicated at few places in the world.

THE UNION PACIFIC COAL COMPANY

One of America's Great Mining Operations

MONTGOMERY R. BUDD

Photographs by WILLIAM A. COONS and STANLEY KERSHAW

PART I

GEOLOGY AND GENERAL OPERATING PRINCIPLES

CONTRARY to popular belief, America's greatest reserves of coal—by far the largest source of our fuel supply—are located in the Far West. North Dakota, for example, has extensive reserves, but little of this coal has been mined because of the lack of large accessible markets and because there is an adequate supply mined in nearby states where markets do exist. Also, some of the reserve beds are subbituminous in character and not in great demand for present fuel needs. However, it is reassuring that America's potential coal supplies are adequate for centuries, if scientific use is made of them—hydrogenation and utilization of low-grade types, for instance, would be beneficial to future generations the world over.

Leading States in Coal Reserves

Wyoming	462,000,000,000 Tons
North Dakota	309,000,000,000 Tons
Colorado	297,000,000,000 Tons
Montana	211,000,000,000 Tons
Utah	95,000,000,000 Tons

Of the western states, Wyoming is one of the largest current producers of bituminous coal. Since 1865, when 800 tons of Wyoming coal were first

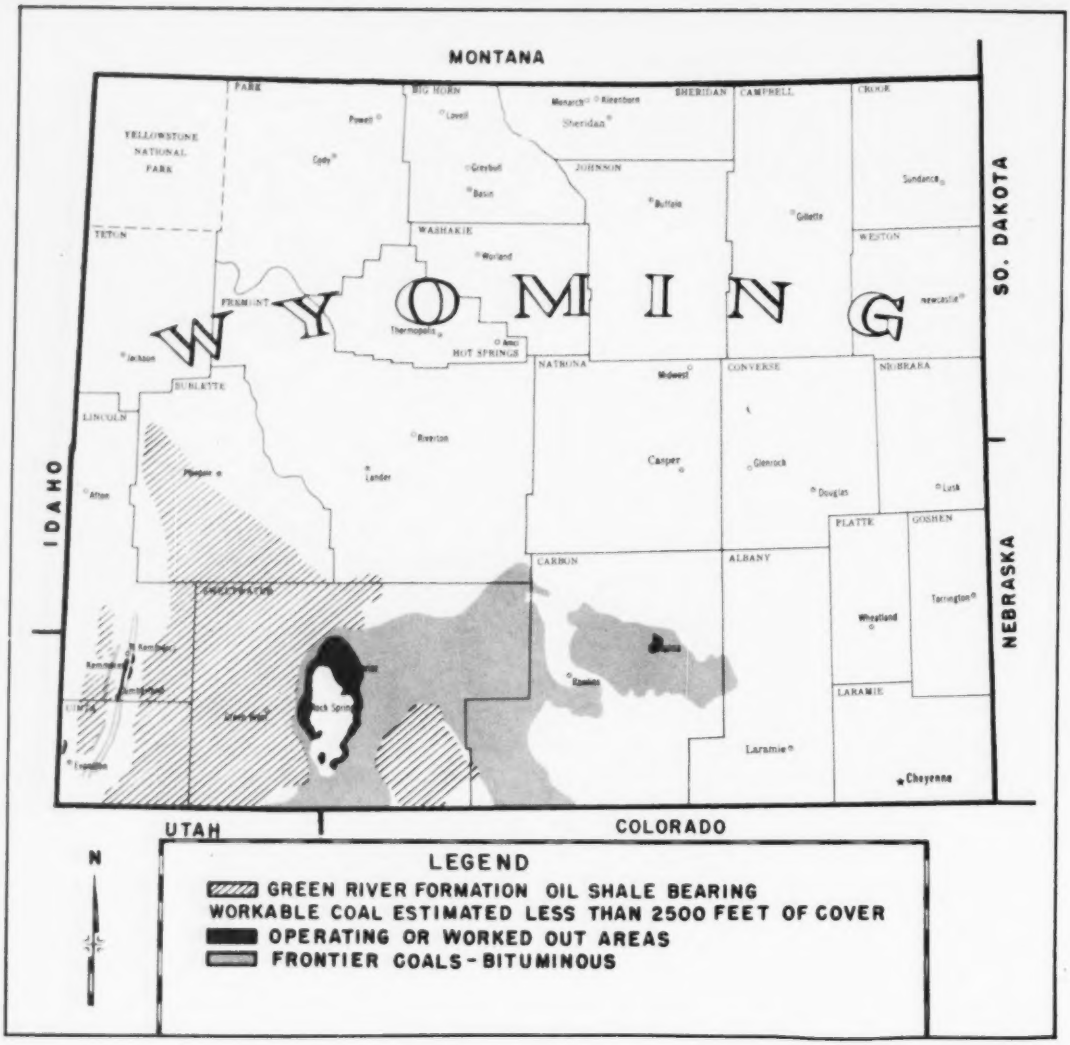


FIGURE 1: Map showing the coal reserves of the State of Wyoming with special emphasis on reserves and bituminous areas in the vicinity of Rock Springs and Hanna.

mined, probably for Army garrison use, Wyoming has been one of the outstanding western coal-producing states. In 1868, when the first Union Pacific mines were opened at Carbon, now a ghost town south of Hanna, and later that year at Rock Springs, present headquarters of The Union Pacific Coal Company, the total production was 6,925 tons. In 1951, total coal output for Wyoming was 6,341,899 tons, of which about 60 per cent was mined by The Union Pacific Coal Company. It is obvious that Wyoming coal mining is vitally concerned with The Union Pacific Coal Company; likewise, The Union Pacific Coal Company is essentially concerned with the Union Pacific Railroad which uses 96 per cent of the coal mined by its wholly owned subsidiary in Wyoming.

The Beginning

Coal in Wyoming was known to the early, almost legendary, fur traders and trappers of the West—pioneers who first noted the thick outcroppings near Rock Springs. Illustrious names, such as Kit Carson, Jim Bridger, Captain John C. Fremont, "the Pathfinder," Captain Howard Stansbury, General William Henry Ashley, are indelibly associated with the exploration of the wild country that led to the route of Union Pacific Railroad and, as a consequence, to the huge coal deposits along the right-of-way.

Yet, luck played a principal role in this discovery and the route of the

Union Pacific. The Blackfoot and Sioux Indians of northern Wyoming were so hostile to the railroad mappers that a projected economical water-grade route through this part of the state was abandoned in favor of a southern route through the land of the peace-loving and friendly Shoshones.

Little did the railroad officials realize that this, the famous Overland Route, contained the vast and unfathomed deposits of bituminous coal so necessary for the operation of the railroad. When the federal government ceded Union Pacific a 400-ft. right-of-way, together with 20 miles of additional land grant on each side, in every other section checkerboard fashion, it was laying the foundation for a coal-mining operation that has helped to make the U.P. a successful railroad venture, because fuel adjacent to a railroad is an obvious economic advantage.

Location and Geology

The Wyoming properties of The Union Pacific Coal Company and its predecessor, the Coal Department of the Union Pacific Railroad, are located in southern Wyoming. One group of mines is located in what is known as the Rock Springs coal fields; the other coal field is located at Hanna, 140 miles east of Rock Springs, on the main line of the U.P. Since 1931, production has been entirely from these two coal fields.

Of 19 districts, explored and developed for coal production since the opening of the properties in 1868, six are actively operated today. Of these, five are in the Rock Springs area; the sixth is at Hanna. Following is a list of the districts operating today, together with tonnages mined through 1951:

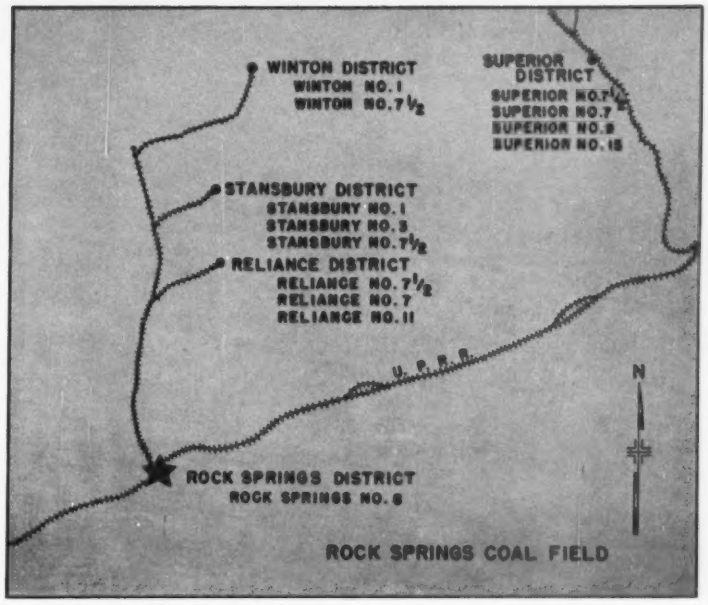


FIGURE 2: The Union Pacific Coal Company mines comprising the Rock Springs coal field are easily accessible from the company's headquarters at Rock Springs.

Name of District	Date Opened	Total Tonnage Mined To Dec. 31 1951
Rock Springs, Wyo.	1868	58,149,943
Superior, Wyo.	1906	37,752,076
Reliance, Wyo.	1911	23,286,969
Winton, Wyo.	1921	14,357,889
Stansbury, Wyo.	1943	5,945,939
Hanna, Wyo.	1890	31,231,572

Geology of Rock Springs Group

The coal seams in the Rock Springs area, comprising the Rock Springs, Superior, Reliance, Winton, and Stansbury districts, are found around the sides of an anticline with a north-south axis. Erosion has removed the strata from the center of the anticline, exposing pitching coal seams with a gradient of from 7 per cent to 30 per cent.

The Rock Springs coal group is of Montana, Late Cretaceous Age. It consists of numerous beds of high-volatile C bituminous coal interbedded with sandstone. It is sufficiently weather-resistant to form hills and sharp escarpments around the margins of the Rock

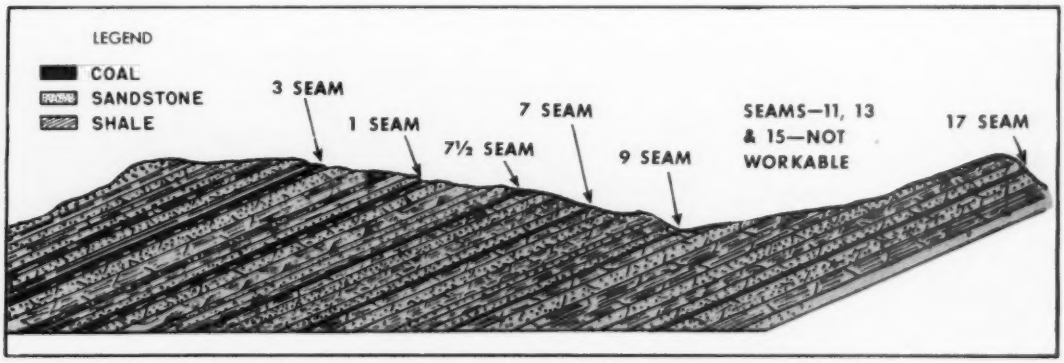


FIGURE 3: Idealized geological section of Winton. Coal measures: horizontal scale, 1 in. equals 150 ft.; vertical scale, 1 in. equals 375 ft.

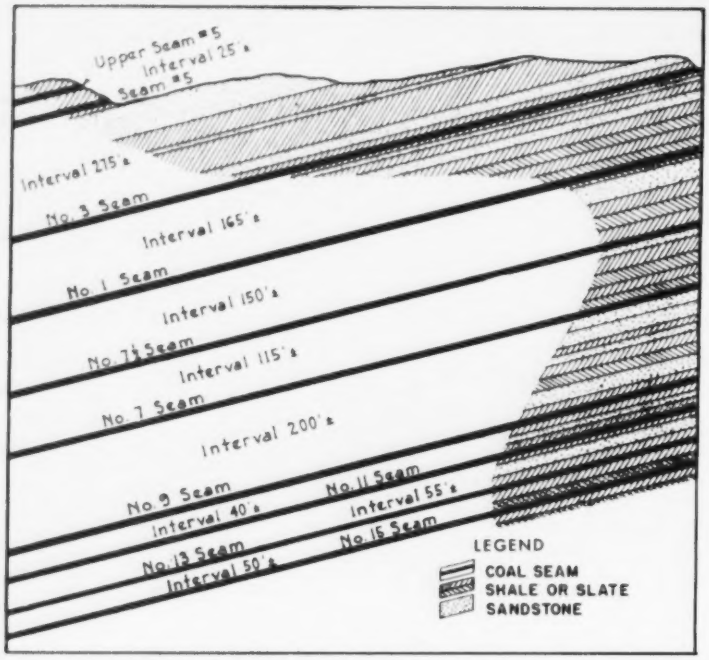


FIGURE 4: Geological section of Rock Springs measures.

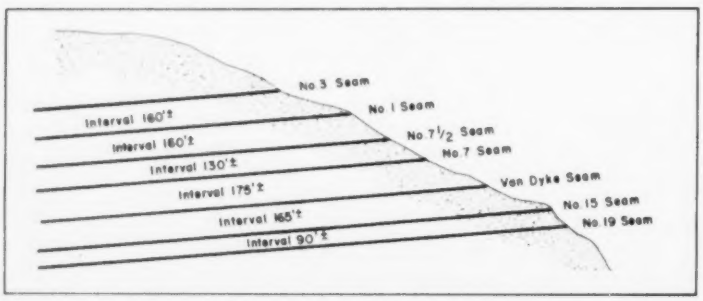
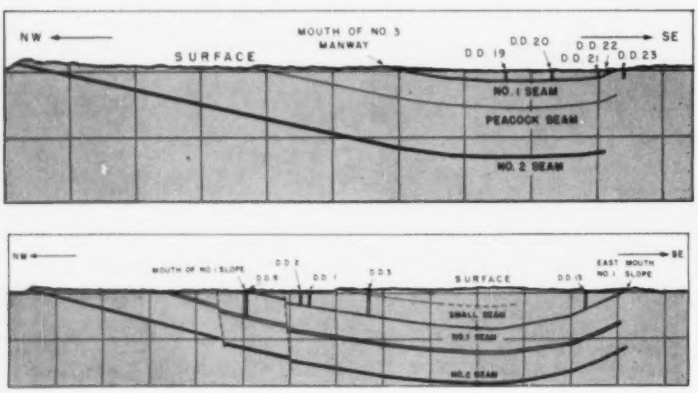


Figure 5: Geological section of Superior Coal measures.



FIGURES 6 and 7: Geological sections at Hanna.

Springs uplift which has exposed the workable seams along the western, northern, and northeastern slopes of the anticline. The workable outcrops extend about 24 miles along the west limb and are generally characterized by their rather steep pitches, ranging from 6 degrees to 17 degrees.

Rock Springs group operations have been divided into separate districts for operating convenience and are named, from south to north, Rock Springs, Reliance, Stansbury, and Winton. The Superior mining district is operated on the northeasterly flank of the uplift and the slopes are comparatively flat, about 4 degrees.

The seams are generally interbedded with a shale top and a sandstone bottom. The coal is very friable and of bituminous rank. Gas has seldom been encountered in the coal mines to date and they are classified nongassy.

Geology of Hanna District

The coal seams at Hanna, Wyoming, which is 140 miles east of Rock Springs, are found around the edges of a syncline with a northeast-southwest axis. These coal seams have a gradient of from 11 per cent to 30 per cent interbedded with a very tender shale top and fire-clay bottom.

The Hanna mines have produced large tonnages from thick seams of early Tertiary Eocene Age, outcropping along the westerly margin of the Hanna basin. These coals are either high-volatile bituminous C, or subbituminous A, depending upon weathering qualities; somewhat higher in moisture content than the Rock Springs coals, and are considered very good locomotive fuel. Mining has been primarily confined to No. 1 and No. 2 seams. Thickness of coal in the area ranges from about 10 ft. to 35 ft. The interval between the seams is such that very little work has been superimposed and the problems of planning and operating multiple seams simultaneously have not occurred in this district.

This coal is less friable, with a high moisture content and at times is subject to spontaneous combustion. The mines are classifieed as gassy by the State Coal Mine Inspection Department.

It will be noted from the accompanying geologic sections that all districts excepting Hanna have a number

of seams *which can be and are operated simultaneously*. This is one of the outstanding features of Union Pacific operations—that multiple-seam mining can be carried on successfully and safely in steeply pitching seams. It is probably unique in American bituminous-coal mining.

General Mining Principles

The following listed mines are now operating in their respective districts. The number of the mine refers to the coal seam in which operations are carried on.

District		
Winton Mine	Winton No. 1	Seam
	Winton No. 7½	"
Stansbury Mine	Stansbury No. 3	Seam
	Stansbury No. 1	"
	Stansbury No. 7½	"
Reliance Mine	Reliance No. 7	Seam
	Reliance No. 9	"
	Reliance No. 11	"
Rock Springs Mine	Rock Springs No. 8	Seam
Superior D. O. Clark Mine	Superior No. 7½	Seam
	Superior No. 7	"
	Superior No. 9	"
	Superior No. 15	"
Hanna 4-A Mine	Hanna No. 2	Seam

In most of the districts, more than one seam can be mined economically. The minimum thickness of merchantable coal was formerly considered to be 5 ft. or more. In recent years, however, seams between 4 ft. and 5 ft. also are being worked economically. In general, the uppermost seams are worked first, pillar extraction in the lower seams being limited to the area in which extraction has been completed in the overlying seams or where the overlying seams are not of workable thickness. It has been found advantageous to work a number of seams simultaneously in order to achieve fairly large daily output from the mines, confining the mine workings to a smaller area than would be necessary if the production were entirely from one or two seams.

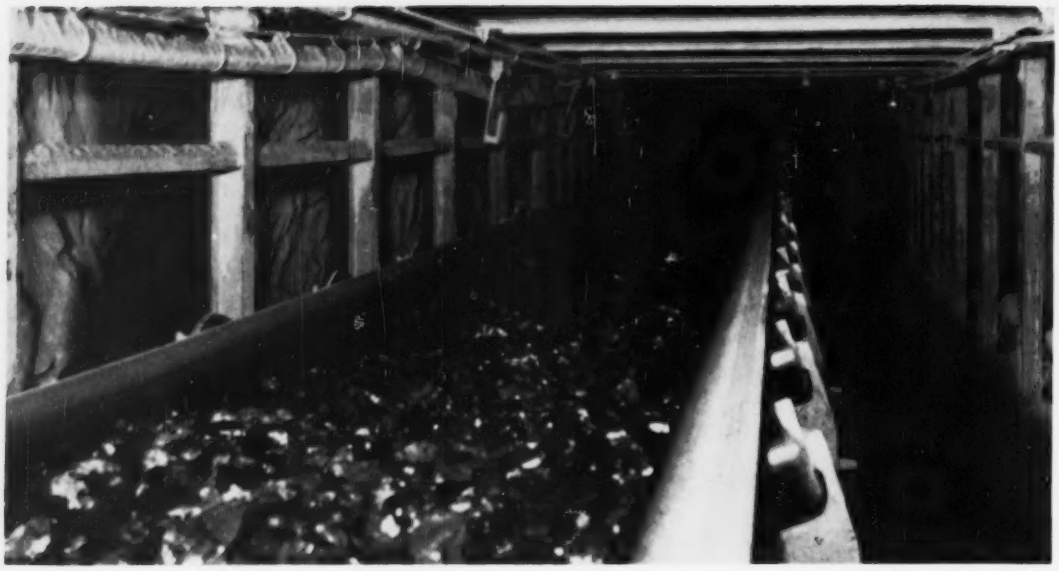
Some 30,000,000 tons, more or less, are now considered sufficient to justify the establishment of a mining district, and in most areas four to six seams of 4-ft.-thick coal will give this recoverable tonnage in fewer than four sections of land. The maximum practical operating depth is now considered to be 1,500 ft. to 3,000 ft. The mines are opened entirely by slopes; vertical shafts are used only for ventilation and escapeway purposes. Coal reserves in the region are sufficient to establish several additional mining districts as the need arises.

Mining with Safety

Brittle roof, steeply pitching seams, and simultaneous operation of multiple seams present operating difficulties that call for the highest degree of organizational skill. That Union Pacific mines have met these challenges with consummate skill and ability is certified by the fact that they have won the Sentinels of Safety trophy for the bituminous-coal mining division of the National Safety Competition for 13 of the 27 years of the contest, including the last five years.

Achieving safety records in bituminous-coal mining under conditions approaching those encountered in anthracite mining is a tribute to the planning, engineering, the study of mining methods, the utilization of modern machinery and equipment, and, above all, to the cultivation of a high *esprit de corps* among 2,300 employes representing 43 nationalities. Without this human relationship, no program involving machines or methods could possibly be successful.

MAIN OFFICE: A familiar landmark in Rock Springs is the large office building, the operating headquarters of The Union Pacific Coal Company.



MECHANIZATION: One of the great advances in mechanical mining is the use of the endless conveyor belt. This 48-in. belt moves the loaded coal from underground dumping station to tipple at Superior D. O. Clark Mine.

PART II

MINING OPERATIONS

UTILIZING 100 PER CENT MECHANIZATION

The Union Pacific Coal Company has always been a disciple of mechanization. As early as 1882, air-operated cutting and drilling machines were installed in Rock Springs No. 4 Mine to help produce a better grade of coal. In 1892, the company took the first step in mechanized hauling by putting into service the first electric mine locomotive ever built in the United States. This locomotive, built by Thompson-Houston Company, was affectionately dubbed "Charlie Smith," in honor of its driver at Rock Springs No. 7 Mine. It now rests on a flower-covered rock foundation in front of the Old Timers' Building at Rock Springs. From this modest beginning came additional electric locomotives, which are now in general use both as main line and auxiliary haulage.

In 1902, a cutting machine of the shortwall type was installed. This type of machine is used to this day. In recent years track-mounted and rubber tire-mounted Universal top cutters have been installed. These can cut both horizontally and vertically, thus speeding the operating cycle.

Mechanical loading was first introduced at Hanna No. 4 in 1916 with the purchase of an excavating shovel to handle coal blasted from the 26-ft. seam. This type of loader was fairly successful, but was replaced by mobile loaders of the Joy 4 BU and 11 BU type in underground operations.

Early in 1925, scraper loading was introduced at Rock Springs No. 8 Mine and was soon extended to other mines at Rock Springs, Reliance, Hanna, and Winton. However, better methods were to be developed and scraper loading was later abandoned, chiefly because of difficulty in operating where timber is set fairly close to the face.

Shaking Conveyors and Duckbills

The first shaking conveyor imported from Bochum, Germany, was installed in Superior in 1926. This machine was so successful that six more were bought in 1926 and 30 more the following year. A retractable pan was used at the face end of the conveyor with the early machines, but only a small part of the coal could be loaded in this manner and it was necessary to shovel most of the coal onto the conveyor by hand.

Later, what is now known as the "Duckbill" was developed at the Rock Springs mines by Frank L. McCarty, superintendent, and George Ernsbarger, a member of the mechanical force. This device, since materially improved, together with the shaking conveyor, has become part of the standard equipment in The Union Pacific Coal Company mines. It is significant that the Franklin Institute awarded McCarty and Ernsbarger a Certificate of Merit for this achievement in mining progress.

By 1933, the mines were 90 per cent mechanized, and in 1937 The Union Pacific Coal Company became the first 100 per cent mechanized large coal-mining operation in the United States.

The recent introduction of mobile loading equipment with Universal cutting machines and shuttle cars is proving satisfactory, resulting in efficient production, loading onto shaking conveyors and panel belts, with or without elevating conveyors.

A further experiment in mechanization is the introduction of two continuous mining machines, one each at Superior and Reliance, used in conjunction with shuttle cars. Of unusual interest is the use of these machines on steep pitches. Definite results on continuous mining machines cannot be ascertained until more experience is obtained in actual use.

The use of 36-in. and 30-in. panel belts at Stansbury and Hanna expedites mechanical handling and is another step toward even more complete mechanization. At Superior, a 48-in. belt carries the coal to the surface. This is a 2,700-ft. haul, with four sections of belt. However, this is supplemented by conventional haulage facilities for handling materials in and out of the mines.

Mining Methods

Basically, the production of The Union Pacific Coal Company is obtained from two operating methods. Shaking-conveyor room-and-pillar work produces approximately 60 per cent of the coal. The remainder—40 per cent—is produced by mobile-loader panel-room-and-pillar work.

In general, where seams range from 16 ft. down to 6 ft. in thickness, the Joy mobile loaders handle the high coal. As the seam narrows, the shaking conveyors are used because they are better adapted for the low coal.

Simultaneous mining of multiple seams is carried on in two seams at Winton; three seams at Stansbury; three seams at Reliance; and four seams at Superior. At the Hanna operation only the No. 2 seam is now being mined.

The present system of entry-room-and-pillar work using shaking conveyors and duckbills is generally used in all coal seams except those of extreme 16-ft. thickness in the Rock Springs area and the 26-ft. coal at Hanna. In most of the Rock Springs area the coal pinches to 4 ft., and this thickness can be mined economically by this method. As previously stated, the mobile loaders are used in the high coal, that is, over 16 ft.

The pitching coal seams, with a gradient of from 14 per cent to 30 per cent, are generally interbedded with a shale top and a sandstone bottom. While classified as nongassy, all work is carried on with the same precautions that would be used in gassy mines.

Following is a description of the three important mining procedures used at the various properties. All are peculiar to conditions encountered at Rock Springs or Hanna, yet each represents sound practices.

DUCKBILL: The shaking conveyor—Duckbill development is almost a Union Pacific trademark. Early in the Twenties, this method of coal extraction received its greatest impetus at Rock Springs.

Shaking-Conveyor Room-and-Pillar Method

At present, mining is being done by unbalanced hoists on the main slopes which are spaced on approximately 3,000- to 4,500-ft. centers with a conventional strike two-entry system on 330-ft. centers. These entries are driven to the boundary line. To have a car clearance for loading and hauling motor trips, it may be necessary in low coal to take up about a foot of bottom in the haulage entry so that 5 ft. of height is maintained, providing 10-in. clearance over the top of the cars.

The two strike entries are driven 12 ft. wide and on 55-ft. centers with room necks turned every 55 ft. Retreat is started from the boundary, working toward the slope by driving rooms up the pitch a distance of 330 ft. and extracting the inside pillar on retreat by pocket-and-stump method.

Haulage in the entries is by 8-ton locomotives pulling 8-car trips. The coal is loaded into 4-ton steel pit cars. The mining in the entries and the rooms is accomplished by cutting with shortwall mining machines; drilling rounds with hand-held electric drills; and utilizing shaking conveyors with self-loading duckbills to remove the blasted coal. For many years this has been the prevalent method—driving rooms up the pitch and loading into pit cars on the haulage levels below. The haulage levels are driven to predetermined boundaries of the blocks to be removed. Room-and-pillar extraction commences with mining two or three rooms—each room extracting the inby pillar on retreat down the pitch. This method is still in use to a large extent; however, little or no new equipment of this type is being purchased, although it produces most of the coal mined.

Because this method might be called roof-control caving, timbering procedure is of unusual interest. In preventing roof falls, straight timbers are set on 5-ft. centers both along and across the pitch. Where necessary, crossbars are set on 5-ft. centers with posts as legs on 5-ft. centers under crossbars. Sawn lagging in 6- to 8-ft. lengths may also be used when required.

In all mines, a breaking row of timber is always set between the timbered mined-out area and the active workings. As the timber is recovered in the mined-out areas, the breaking row (three rows of timber on 18-in. centers) limits the extent of caving and always separates mined-out areas and active working places. The overall picture of a mine always shows a 45-degree break line between solid coal and mined-out area, such that most of the weight of the mined-out area is transmitted to the solid coal on down the pitch from the active workings.

Blasting Procedure

In advancing rooms, a 24-ft. face is blasted in sequence, using two rows of 7½-ft. holes and an 8-ft. undercut. The

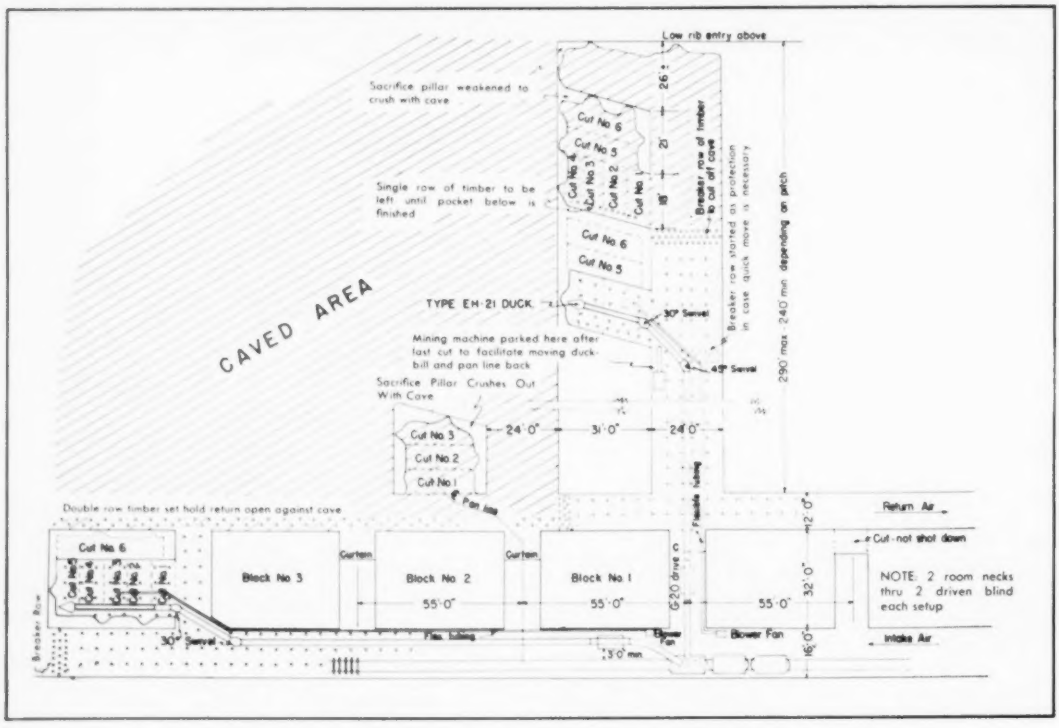


FIGURE 8. Diagram of the system used in mining most of the coal in the Rock Springs area by entry-room-and-pillar method, utilizing shaking conveyors.

SPECIAL MACHINE: Raising timber with a specially designed machine affords another demonstration of the combination of safety and efficiency achieved by "U.P."

staggered holes are drilled with 1½in. auger drills with McLaughlin "throw-away" bits. Goodman, Sullivan, and Jeffrey shortwalls are used. Holes are loaded with from two to four cartridges of Red H* F permissible explosives. Stemming, prebagged from a nearby source, fills each hole to the collar. Blasts are fired individually, in sequence from 1 to 9, with a single-shot permissible blasting machine.

Room-and-pillar cuts are made much the same way, with an 8-ft. undercut and staggered rounds drilled in two rows, five on the top row and four on the bottom. As shown in the diagram, these rounds are also fired in sequence to get maximum breakage and a greater percentage of lump. Only one hole is wired at a time. After blasting, one or two miners return to the face and wire the next hole in preparation for firing another blast.

All explosives are carefully handled. First requirement is that each unit powder box contains but a day's supply of permissible explosives in each entry. These boxes are located about 200 ft. outside and away from power supply and haulage. There is a main explosives magazine in each coal seam or each mine. These, too, are protected from power and haulage.

(There is more discussion on handling and use of explosives in a special section of this article.)

*Reg. U. S. Pat. Off.

Mobile Loaders at Hanna No. 4-A Mine

Working in 26-ft. coal at Hanna 4-A Mine is one of the most unusual coal-mining operations anywhere. The extreme height of the coal makes timbering impossible, and the gradient of 18 per cent, and higher, complicates the problem. The development of panel-belt mining with mobile loaders—a trackless mining system—has resulted in mining efficiency under adequate safety conditions.

Mining is conducted by unbalanced rope haulage on main slopes spaced on approximate 5,000- to 6,000-ft. centers and three strike entries driven to boundary lines, strike entries being turned on approximate 1,300-ft. centers.

Three place panels are developed to the rise between strike entries by use of three shaking conveyors equipped with automatic duckbills. Panels are spaced on 1,300-ft. centers and the three shaking conveyors discharge onto a portable belt conveyor located in the center place. The shaking conveyor driving the center place turns the panel crosscuts, with the exception of blind crosscuts. The shaking conveyors driving the outside places turn the room necks. In Figure 9, it is shown that the fourth place is driven at the bottom of the panel to establish positive ventilation during period of panel development. The 26-ft. coal seam is of definite advantage in providing over- and undercasts for ventilation purposes.

In Figure 10, it is seen that the room necks are staggered on the opposite side of the panel with room centers of about 75 to 100 ft., and the shaking conveyors are advanced or moved every 225 ft. with the required addition of 225 ft. of portable belt conveyor in sequence with the shaking conveyor moves.

All Track Eliminated

This method of panel development provides for the elimination of all track

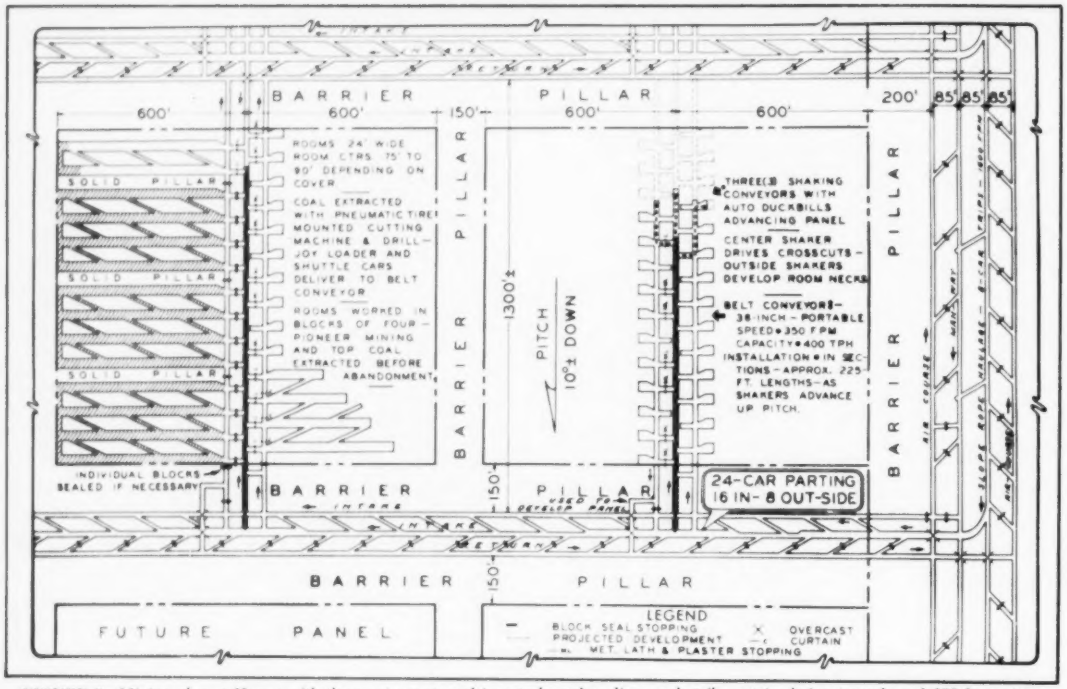


FIGURE 9. Mining plan at Hanna with three-entry system driven to boundary lines and strike entries being turned on 1,300-ft. centers.

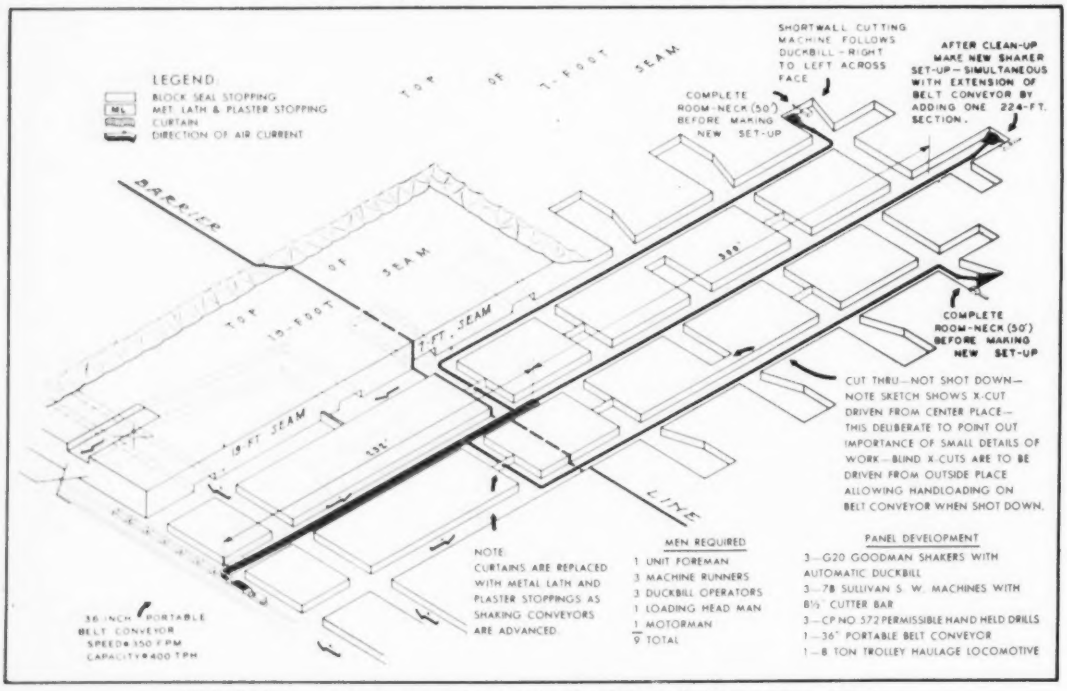

LEGEND
BLOCK SEAL STOPPING
MET. LATH & PLASTER STOPPING
CURTAIN
DIRECTION OF AIR CURRENT
TOP OF 7-FOOT SEAM
SHORTWALL CUTTING MACHINE FOLLOWS DUCKBILL—RIGHT TO LEFT ACROSS FACE
AFTER CLEAN-UP MAKE NEW SHAKER SET-UP—SIMULTANEOUS WITH EXTENSION OF BELT CONVEYOR BY ADDING ONE 224-FT. SECTION.
COMPLETE ROOM-NECK (50') BEFORE MAKING NEW SET-UP
BARRIER
TOP OF SEAM
TOP 10-FOOT SEAM
7 FT. SEAM
10 FT. SEAM
COMPLETE ROOM-NECK (50') BEFORE MAKING NEW SET-UP
CUT THRU—NOT SHOT DOWN—NOTE SKETCH SHOWS X-CUT DRIVEN FROM CENTER PLACE—THIS DELIBERATE TO POINT OUT IMPORTANCE OF SMALL DETAILS OF WORK—BLIND X-CUTS ARE TO BE DRIVEN FROM OUTSIDE PLACE ALLOWING HANDLOADING ON BELT CONVEYOR WHEN SHOT DOWN.
LINE
NOTE:
CURTAINS ARE REPLACED WITH METAL LATH AND PLASTER STOPPINGS AS SHAKING CONVEYORS ARE ADVANCED.
MEN REQUIRED
1 UNIT FOREMAN
3 MACHINE RUNNERS
3 DUCKBILL OPERATORS
1 LOADING HEAD MAN
1 MOTORMAN
9 TOTAL
PANEL DEVELOPMENT
3—G20 GOODMAN SHAKERS WITH AUTOMATIC DUCKBILL
3—7B SULLIVAN S. W. MACHINES WITH 8½' CUTTER BAR
3—CP NO. 572 PERMISSIBLE HAND HELD DRILLS
1—36" PORTABLE BELT CONVEYOR
1—8 TON TROLLEY HAULAGE LOCOMOTIVE
36-INCH PORTABLE BELT CONVEYOR SPEED • 350 F.P.M. CAPACITY • 400 T.P.H.

FIGURE 10. Room necks are staggered on opposite sides of the panel with room centers of 75 ft. Shaking conveyors are moved every 225 ft. of additional portable belt conveyor.

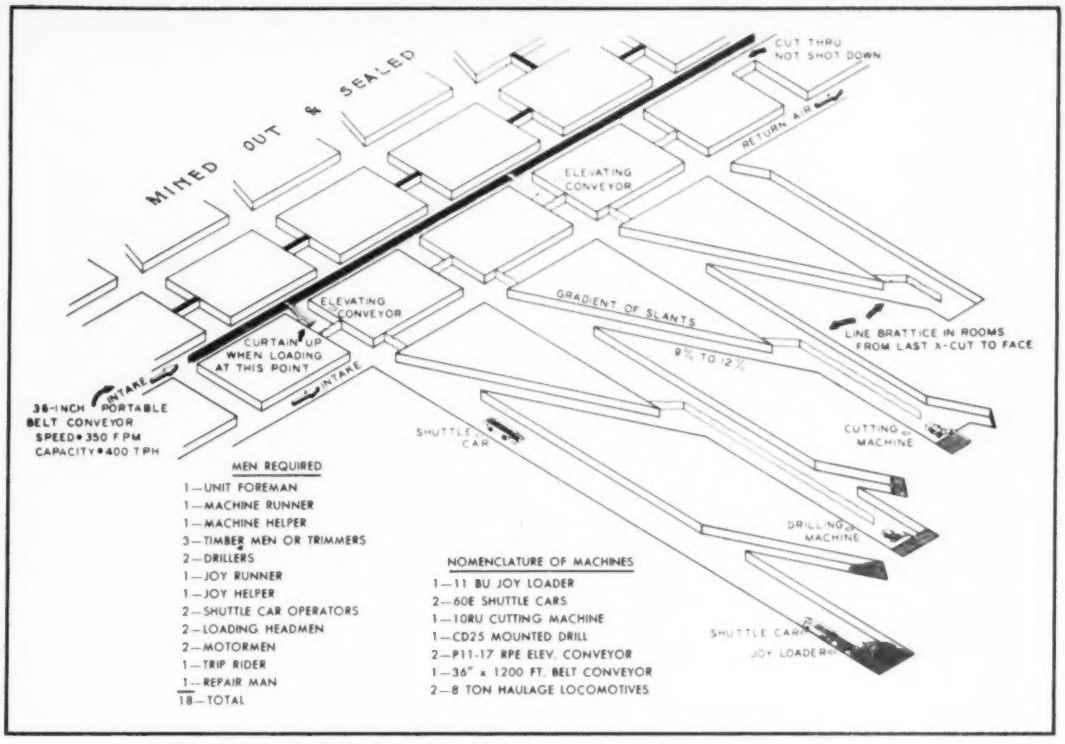


FIGURE 11: The procedure for mining a block of four rooms is illustrated here. Slant crosscuts are driven between rooms on 9 to 12 per cent grade to facilitate the handling of loaded shuttle cars.

work on the panel, elimination of development hoist at the lower end of the panel, together with the services of a hoisting engineer and rope rider to service the shaking conveyors as they are advanced up the pitch; the belt conveyor replaces the development hoist and track, and one loading headman executes the work formerly performed by the hoisting engineer and rope rider. This facility also improves pit-car service to the shaking conveyors and eliminates, to a great extent, delays awaiting car service.

It is also necessary to plan the number of panel crosscuts and room necks to be developed by each shaking conveyor so that proper balance of work is provided for each unit to keep the shaking conveyors in step in advancing the panel.

The shaking-conveyor units are removed through the entry above, and the trackless mining equipment installed to drive the first block of four rooms on the lower and inby side.

Pioneer Room Mining

Upon completion of the panel development, the belt conveyor is completely installed, ventilation established to the return aircourse above, and the panel is now ready for pioneer room mining.

Figure 11 illustrates the procedure of mining a block of four rooms.

Pioneer room mining in the 26-ft. seam is accomplished by use of a 10 RU pneumatic-mounted cutting machine with places driven 24 ft. wide, top cut 10 ft. high, and center sheared. Drilling is done by a CD-25 rubber tire-mounted drill; loading by an 11 BU Joy loader into two 60E 10-ton shuttle cars tramming to elevating conveyor, discharging onto a 36-in. belt conveyor.

Slant crosscuts are driven between rooms on a gradient of 9 to 12 per cent in favor of loaded shuttle cars. Two elevating conveyors are employed, providing two points of loading onto the belt for each block of four rooms.

During pioneer room mining, ventilation is conducted to the working faces by use of line brattice from the last open crosscut, with return air from the last room to the rise coursing through the panel to the return aircourse above. Of course, it is important to maintain a positive method of ventilation in a potentially gassy condition.

When pioneer work in rooms is completed to destination, extraction of top coal is started retreating from face. The top coal is cut, drilled, and shot down in blocks 100 ft. long, furnishing approximately 2,500 tons a fall for continuous loading. Sometimes the top coal is mined in two steps, "semi-tops" and "tops"; removal of part of the coal provides room for swell due to breakage from shooting.

The sequence of top-coal extraction in rooms and room slant crosscuts begins with the top coal in the room proper being extracted back to within approximately 20 ft. of the lower rib of the slant crosscut above. This leaves a bridge of top coal to support the

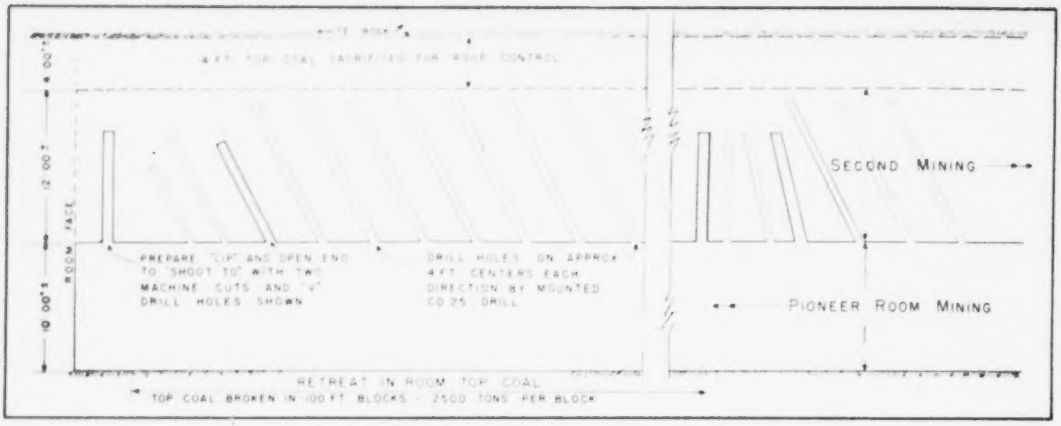

4 FT. TOP COAL SACRIFICED FOR ROOF CONTROL
12 00"
FACE
10 00"
SECOND MINING
PREPARE "LIP" AND OPEN END TO "SHOOT TO" WITH TWO MACHINE CUTS AND "V" DRILL HOLES SHOWN
DRILL HOLES ON APPROX 4 FT. CENTERS EACH DIRECTION BY MOUNTED CD 25 DRILL
PIONEER ROOM MINING
RETREAT IN ROOM TOP COAL
TOP COAL BROKEN IN 100 FT. BLOCKS - 2500 TONS PER BLOCK

FIGURE 12. Diagram illustrating the method of top-coal extraction. Note that 4 ft. of top coal is sacrificed for roof control and lip cuts are made before machine is removed from the room.

narrow pillar at this point. The top coal is then pulled back in the slant crossent to the high rib of the room and another block of top coal extracted in the room proper. Joy loaders, shuttle cars, and two elevating conveyors are utilized in removing the top coal from the block of four rooms. All top coal is removed from the block of four rooms before abandoning. This permits the sealing of individual blocks of four rooms if necessary. A solid pillar between each block of four rooms is left for the purpose of sealing.

The major problems in top-coal extraction in the Hanna field are roof control, the preparation of "lips," and top-coal drilling. This was formerly done by hand drilling and a large amount of pick work to trim top coal "lips" properly. This resulted in an item of major expense of top-coal mining. After the first bench of top coal was removed, the drilling was done from the top-coal piles with hand-held drills.

The present method of top-coal extraction provides for the usual sacrifice of 4 ft. of top coal with the "lips" prepared by application of a vertical and slant cut with the 10 BU machine, as illustrated in Figure 12. The "lip" cuts are made before the machine is removed from the room.

Slant holes are drilled as shown with the CD-25 mounted drill on approximate 4-ft. centers in each direction. Detail method of loading top-coal holes is shown in Figure 13; this method being to load the back or top end of the hole with three cartridges of 1¼ in. by 8-in. permissible powder, apply stemming, then load three more cartridges and stem to the collar of the hole. This is best accomplished by use of a trough in loading the holes. Two No. 6 detonators are used in each hole with five holes across the room which permit the use of a permissible ten-shot blasting machine. The placing of the powder as shown and shooting to an open end make possible good preparation and elimination of very large lumps usually found in top-coal shooting. It is necessary to eliminate large chunks because of the use of belt-conveyor haulage.

The panel development system provides for a continuous cycle of operation, which is vital in mining efficiency. The cutting machine is sumped in the corner of the working place after cleaning with the duckbill. Then follows the preparations for blasting across the working face, with drilling, loading, and shooting following in sequence. Nine miners are adequate for this operation. It takes 200 machine shifts to develop the panel proper.

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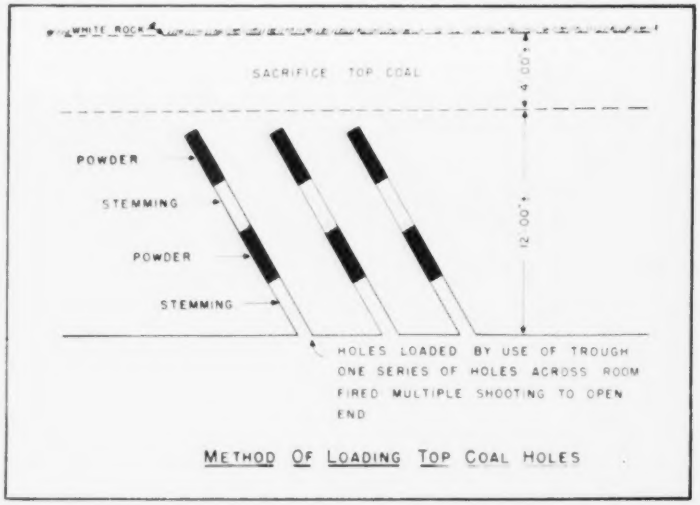


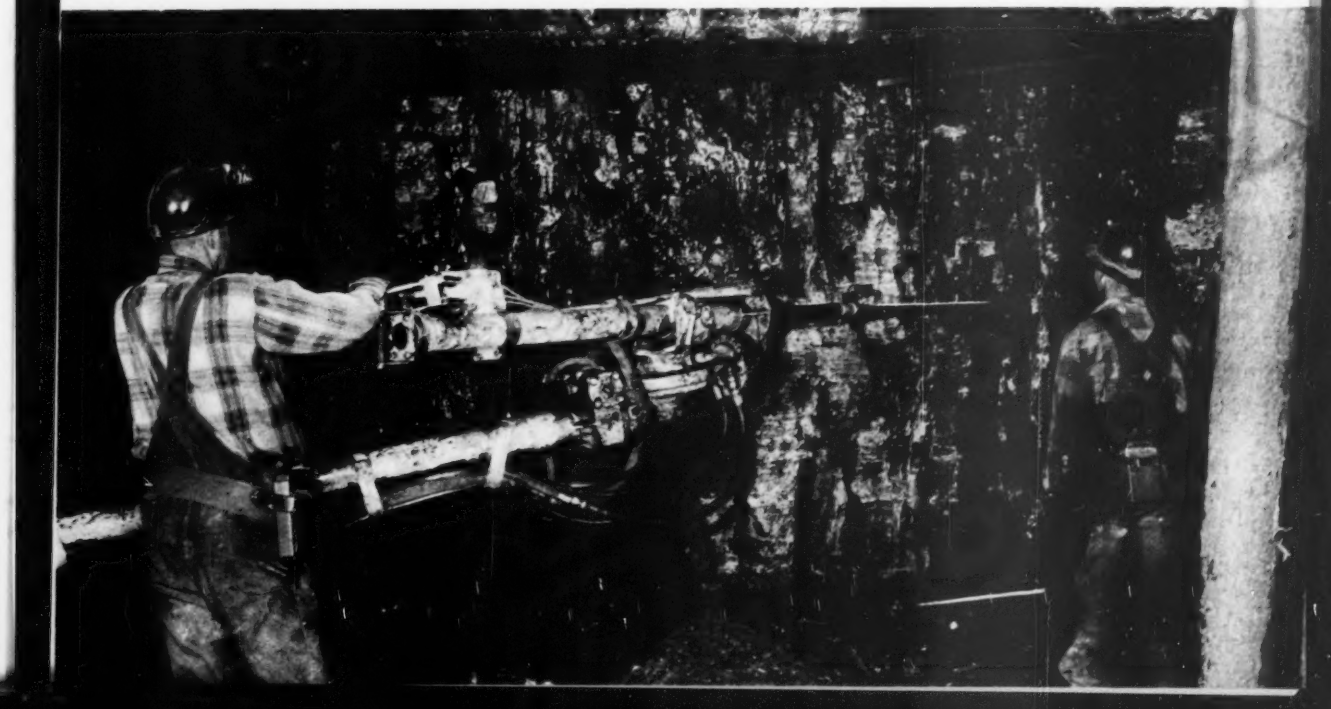
FIGURE 13: Detail method of loading top holes after the pioneer mining has been completed.

MAKING THE CUT: With timber properly set and coal from previous blast mined out, the 70 UR Universal cutting machine prepares the face for the next mining cycle.

UNION PACIFIC OPERATING CYCLE

The Heart of Coal-Mining Production

DRILLING: A rubber-tired machine, mounting a CD-25 electric auger drill, is wheeled into position; 1¼-in. holes are drilled with McLaughlin "throwaway" bits.



PREPARING THE CHARGE: Two rows of 7½-ft. holes are drilled the 16-ft. face, making a total of 14 holes a round. Each charge consists of two to four cartridges of Red H F permissible explosives.

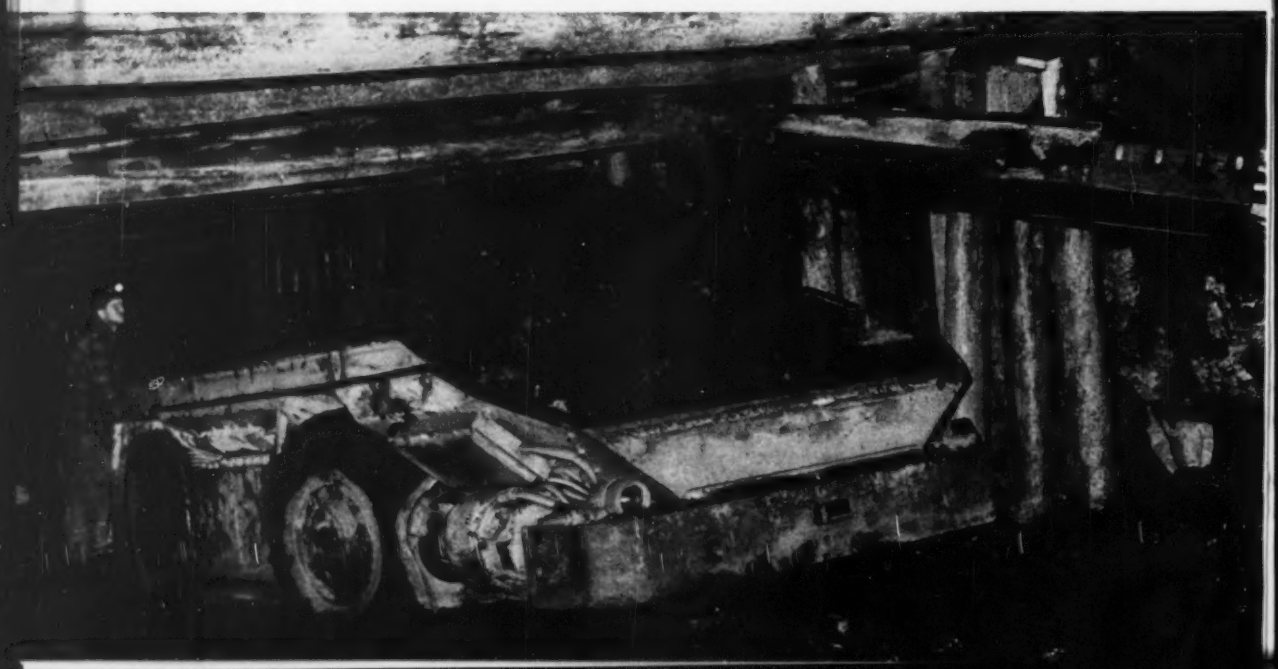
THE PRIMER GOES IN: Pre-bagged stemming is trammed into the mine, and tamping is placed to the collar of each hole. Rounds are fired in sequence for maximum lump production.

THE BLAST: Shots are fired individually in the interest of safety and production. Only one hole is wired at a time. Powder boxes are located away from power supply and haulage.

THE RESULT: Properly placed charges, properly wired and fired, result in good breakage into lump convenient for handling. Note that the coal is blasted down for easy loading.

MECHANIZATION: After protection from the blast, a crawler-type loader quickly moves in and loads the blasted coal from the 16-ft. face to the waiting shuttle cars.

SHUTTLE CAR: Here is an example of trackless mining, with a 10 SC 7-ton shuttle car handling the coal from loading machine to elevating conveyor, and finally to a 48-in. belt for conveying to the tipple.



The Union Pacific Coal Company

(Continued from page 82)

including 45 shifts provided for moving shaking conveyors and installing belt conveyor. Each machine averages 67 tons per shift—an output of 200 tons a day in the panel-development operation.

The continuous cycle of operation of cutting, drilling, and loading is illustrated in Figure 11. The labor personnel as set forth is adequate to maintain a complete and continuous cycle of operation in pioneer room mining and top-coal extraction. The three men indicated as timbermen or trimmers, together with the electrical and mechanical repairmen, execute dead work; that is, necessary timbering, extension of line curtains, trimming of "lips" and ribs. Production from pioneer room mining is the cutting, drilling, and loading of seven places or 500 tons a shift. Production from top coal is 800 tons a shift.

Advantages

The principal advantages of the trackless mining system at Union Pacific are as follows:

1. The elimination of track in panel and rooms.
2. The elimination of panel development hoist.
3. The elimination of panel hoist installation.
4. The saving on power consumption effected by use of a 40-hp. belt conveyor in lieu of 200-hp. panel hoist.
5. Mine-labor saving on panel development because of more efficient operation.
6. Labor saving on pioneer room and top-coal mining because of more efficient operation.

Trackless Mining at Stansbury No. 1 Mine

At Stansbury No. 1 Mine, 16-ft. coal is encountered, but the problems inherent at Hanna, which mines a 26-ft. seam of coal, are not so formidable at Stansbury.

Mining at Stansbury No. 1 Mine is conducted in a 16-ft. coal seam laid down on an anticline structure with the axis eroded away, leaving the active working on a pitch of approximately 12 degrees or 22 per cent gradient. The coal seam is interbedded with a sandstone bottom and shale top. This coal is friable, contains less moisture and is subject to spontaneous combustion. Mining is done by unbalanced hoists on the main slopes, which are spaced about 3,500 ft. apart.

In the present system, entries are driven on 1,200-ft. centers instead of the 330 ft. previously used. Three place panels are developed 1,200 ft. to the rise on 900-ft. centers, employing shaking conveyors discharging onto a portable belt conveyor similar to the Hanna plan.

This method of panel development eliminates track-and-trolley work in three entries with the corresponding amount of strike development, or narrow work, and necessary ventilating door or overcasts for ventilation.

Controlled Caving

Strike rooms are driven 24 ft. wide and 400 ft. long on 55-ft. centers. Since complete mining and controlled caving are practiced at Stansbury, room-and-pillar work must be started at the top and inside of each panel, as shown in Figure 14. Caving is controlled and kept adjacent to the active mining, to relieve the pressure on the pillars which are mined from the lower side.

The shaking conveyor units used to develop the panel are temporarily pulled to one side after panel development is complete and the trackless mining equipment installed to drive the first block of four strike rooms on the top inby side of the panel. After room-and-pillar coal extraction is completed on both sides of the top end of the panel, the shakers are installed to extract the top coal in the panel, panel pillars, and the last pillar in each room. This must be done as soon as possible as a squeeze comes on the panel where coal is removed on both sides.

As shown in Figure 14, a fifth room is driven with the block of four rooms, to assure an ample number of faces, especially when pillar mining is nearing completion in the four rooms. This also assists in the staggering of mining in the succeeding rooms, as the room generally is only partially developed before the mining in the four rooms above is completed.

The strike room-and-pillar mining is accomplished by a 70 UR pneumatic-mounted cutting machine, a CD-25 rubber tire-mounted drill, a rubber tire-mounted timbering machine

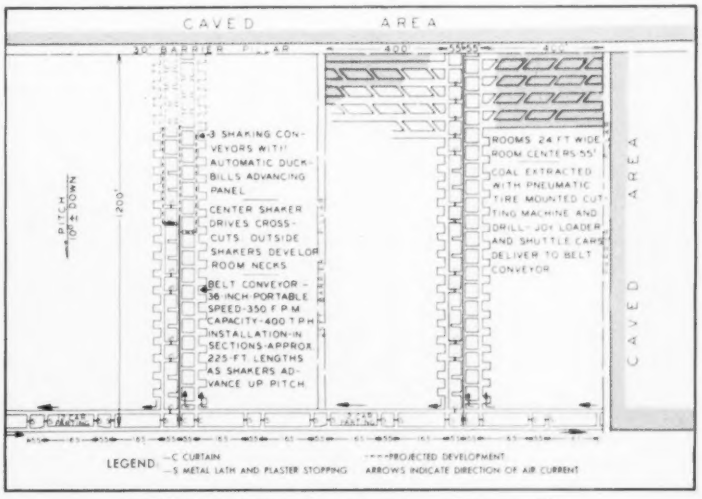

CAVED AREA
20' BARRIER PILLAR
400'
4 ENTRIES
3 SHAKING CONVEYORS WITH AUTOMATIC DUCK-BILLS ADVANCING PANEL
CENTER SHAKER DRIVES CROSS-CUTS. OUTSIDE SHAKERS DEVELOP ROOM NECKS
BELT CONVEYOR - 36 INCH PORTABLE SPEED-350 F P M CAPACITY-400 T P H INSTALLATION IN SECTIONS-APPROX 225-FT. LENGTHS AS SHAKERS ADVANCE UP PITCH
PITCH
TOP
DOWN
1200'
ROOMS 24 FT WIDE ROOM CENTERS 55' COAL EXTRACTED WITH PNEUMATIC TIRE MOUNTED CUTTING MACHINE AND DRILL. JOY LOADER AND SHUTTLE CARS DELIVER TO BELT CONVEYOR
CAVED AREA
LEGEND: —C CURTAIN
—S METAL LATH AND PLASTER STOPPING
----PROJECTED DEVELOPMENT
ARROWS INDICATE DIRECTION OF AIR CURRENT

FIGURE 14: Mining plan at Stansbury utilizing trackless mining system for a pitching seam in 16-ft. coal.

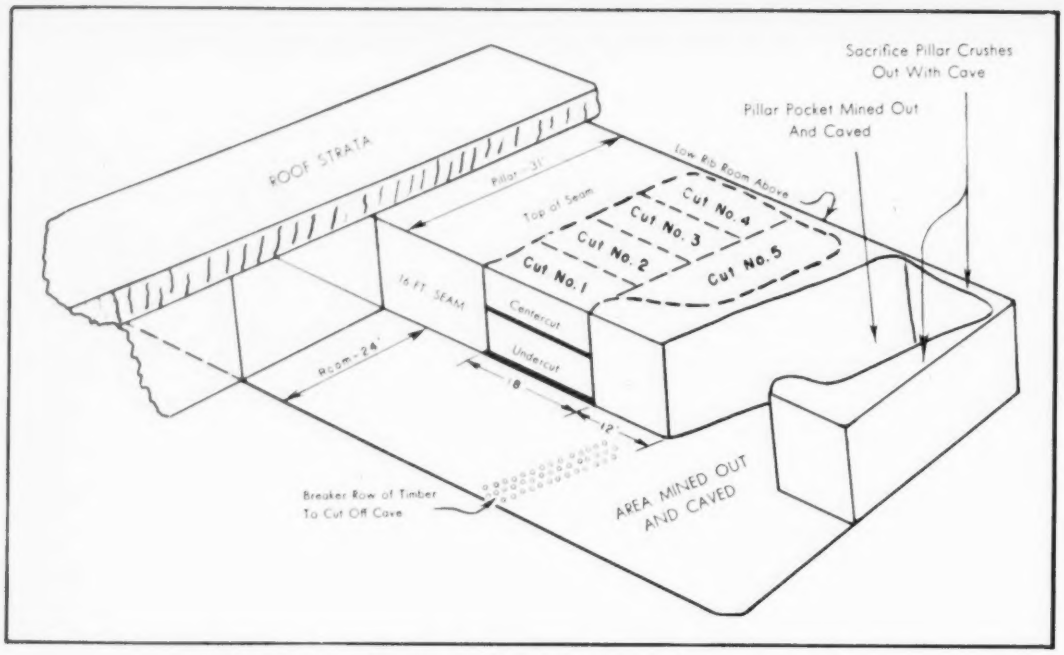


FIGURE 15: At Stansbury No. 1, the full 16-ft. of coal is mined as the room is advanced. The diagram shows the method of pillar recovery.

designed on the properties, a 14 BU Joy loader, and two 10 SC 7-ton shuttle cars tramming to the elevating conveyor which discharges onto a 30- or 36-in. belt conveyor.

Driving Crosscuts

Slant crosscuts are driven between rooms on a gradient of approximately 11 per cent in favor of the loaded shuttle cars. Two elevating conveyors are employed, providing two points of loading onto the belt for each group of four rooms, similar to the Hanna operation.

Ventilation into the working face is by blower fans located in the fresh air brought up the two inby places of the panel. The return air travels down the outby place and out the top entry.

A solid barrier pillar can be left between each block of four rooms on each side to permit sealing of the mined-out area, if necessary.

The full 16 ft. of coal is mined as the room is advanced, and the 16 ft. of coal in the pillar taken by pocket-and-stump method on the retreat, as shown in Figure 15.

Timbering in the room-and-pillar mining is done with 20-ft. crossbars on 5-ft. centers in the room and 16-ft. crossbars on 5-ft. centers in the pillar, installed by two men and the timbering machine illustrated on page 79.

Figure 16 shows the cutting and drilling necessary for face preparation in the room. The face is first undercut and then horizontally sheared 8 ft. above the bottom. The 14 holes are drilled and loaded with three to four cartridges of permissible explosives. Each prepared face will produce approximately 120 tons of coal, and production from room-and-pillar work is 600 tons a shift.

The labor personnel required to maintain a complete and continuous cycle of operation in room-and-pillar mining is as follows:

1 Unit Foreman
1 Machine Runner
1 Machine Helper
2 Timbermen
2 Drillers

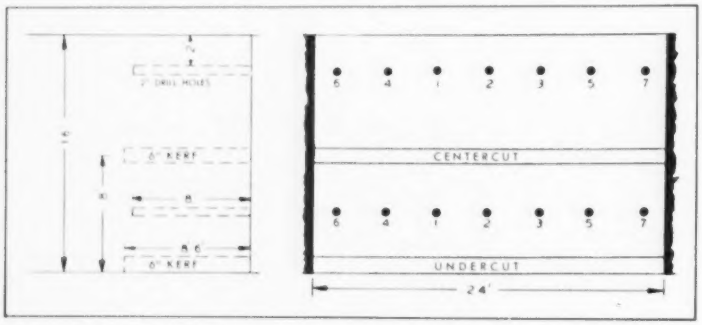


FIGURE 16: Detail for undercutting, shearing, and drilling the face at Stansbury No. 1. Holes are fired individually.

1 Joy Runner
1 Joy Helper
2 Shuttle Car Operators
1 Loaderhead Man
2 Motormen
1 Repairman

15 Total

The two timbermen and the repairman perform dead work such as necessary timbering, extension of power lines, and maintenance and cleaning of the belt.

Advantages

The principal advantages of the panel-belt system can, therefore, be listed as follows:

1. The elimination of tracks, trolley, and ventilating doors, or overcasts, in three entries.

2. The reduction of the amount of strike development or narrow work.

3. The labor saving in room-and-pillar work because of efficient operation.

Simultaneous Mining of Multiple Seams

Multiple-seam operations are a feature at Union Pacific. At Superior, for example, four seams are mined simultaneously, and at one time five seams were mined at once. At Stansbury, three seams are being operated simultaneously.

Basically, the plan is to start at the top seam, mine out the coal, and permit the roof to cave for 200 ft. to 300 ft. Country rock and other debris will cave with the overlying material.

Work cannot go on in the second and subsequent seams until all the mineable material above has been removed. This gives a staggering pattern in profile, and one which follows in section the mining plan of the various seams. Thus, four seams are operated at once, but the working face in each seam is protected by cover above. When caving is done, each mining face moves closer to the main haulageway.

A stylized cross section at Superior, where the 48-in. conveyor belt carries the coal to the surface, gives some conception of the methods used in working four seams together in that district.

Roof Bolting

The use of timbers to support roof is as old as mining itself. However, as in all industries, progress is being made in this phase of roof support with the use of roof pinning by means of bolts driven in the roof, and anchored by plates to keep the roof intact. Tried in Reliance No. 11 Mine two years ago, the method is proving successful, and is now being used, to some extent, in all mines.

The basic principle involved in roof pinning is the reinforcement of rock by means of steel rods and anchored at points where the effects of mining stresses are least likely to cause rock failure. Roof rock in the Reliance No. 11 Mine consists of thin laminated shale and sandstone. Roof failures occur frequently along haulage roads, causing high support costs. By supplying reinforcing material and roof bolts to provide additional beam strength, it is hoped that this type of roof failure will be minimized.

Physical conditions in the No. 11 Mine at Reliance require very heavy timbering, with the hazards of frequent replacement of wood timbers.

To take full advantage of the suspension roof support, it is necessary to install the bolts as soon as possible after the roof is exposed, and as close to the face as practicable. A 60-degree angle 1¾-in. hole is drilled about 5 ft. deep with an electric hydraulic rotary drill. Water is used during the drilling operation to eliminate airborne dust. A 5-ft. rod, 1 in. in diameter, is inserted in the 1¾-in. holes drilled on approximate 4-ft. centers. After the first rod hole is drilled, a tightening dolly is placed on the end of the threaded rod-head and tightened with the drill. The purpose of the tightening dolly is to protect the threads on the end of the rod. A steel plate is secured to the roof with an angle washer and nut, in the process of tightening the rod.

This method of roof control, which appears to support itself instead of being supported by straight timbering and crossbars, gives the feeling, first, of insecurity, and is sometimes called "sky hooks." But its successful use gives a great feeling of security.

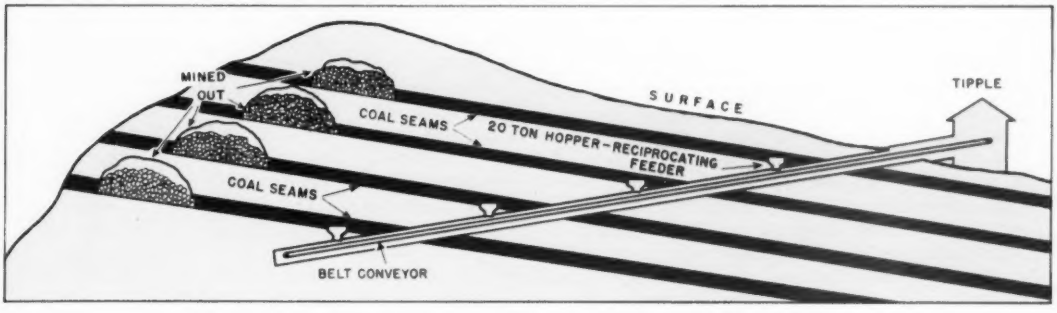


FIGURE 17: Idealized section illustrating multiple-seam operations at Rock Springs. Note that pitching seams make this work comparable to conditions encountered in anthracite mining.

SAFETY IN ACTION: Rock dusting might be termed the trademark of safety in coal mining. Here, a portable machine is in operation at Superior.

PART III

THE SAFETY PROGRAM

"Safety is simply a matter of organization and training, mixed with perseverance and hard work. It embraces every company employe, not only miners, but all other workers and members of the supervisory staff, including the president."

J. N. Bayless, President
The Union Pacific Coal Company

There you have in capsule form the chief reason for the most remarkable and successful coal-mining accident-prevention program ever devised in the United States. Its success can be measured, of course, in terms of trophies and honors won, but more basically its success can be measured in terms of lives saved, accidents prevented, and the elimination of human misery and a large measure of unhappiness.

For 13 years, mines of The Union Pacific Coal Company have won the Sentinels of Safety trophy for the bituminous-coal mining division of the National Safety Competition. For the last five years in succession, the award has gone to a Union Pacific property. Strangely, it is not always the same mine that wins, although Reliance No. 7 has won the last four years. No, it is company-wide safety organization that affects every mine and every individual miner that makes possible the consistent success of one of the remarkable accident-free programs in industry.

Certainly, Union Pacific has accidents. In fact, last year there were three fatal accidents in the mines. But let's not overlook the fact that mining conditions are naturally difficult, with pitching seams, roof rock consisting of thin laminated shale and sandstone, with simultaneous operation of multiple seams in some of the properties, and with awkward 16-ft. to 32-ft. seams to be mined in other areas.

Top management of The Union Pacific Coal Company believes that it must accept its responsibility for safety, and that if safety is to be effective it must reach every corner of the property, be evident at all company meetings, and, above all, be so instilled in all supervisors that they will set excellent safety examples for their men.

It is interesting that Vernon Murray, vice president of operations, spent four years in the Twenties as first-aid miner and foreman miner on U. S. Bureau of Mines' cars teaching first-aid and mine-safety work to miners in the Rocky Mountain region. During his first seven years with Union Pacific, Mr. Murray was safety engineer and thus was in a position to interpret the miners' viewpoints of safety. Today, he is just as safety-conscious as ever in

handling the company's overall operating program—just an example of the interest of U.P.'s top management in its safety program.

The present safety engineer, Frank J. Peternell, maintains the traditional importance of safety in the Union Pacific operating scheme. A coal miner himself, and a graduate mining engineer, he brings to his position a blend of practical mining and technical knowledge. And, in his own right, the stature of his position is recognized in all staff meetings of the company.

The prime fundamental for sound safety promotion is a genuine desire for safety, which Union Pacific possesses. Since it is responsible for the success of a safety program, management must fulfill a triple obligation, as follows:

1. The conditions under which employes must work should be made as safe as present-day methods will permit.

2. All employes must be educated by management and sold on the principles of safety to make them safety-conscious.

3. Duty to the company demands that plant and equipment be used and operated free of danger and damage.

History of U.P. Safety

Since the time of the opening of the first Union Pacific mine in southern Wyoming in 1868, the Union Pacific Coal Department, and, later, The Union Pacific Coal Company have worked toward the solution of the problem of danger underground; but it was not until 1911 that any organized attempt was made to increase mine safety through the education of miners themselves. In that year, the United States Bureau of Mines sent a Mine Safety Car to the western coal-mining districts under the charge of Sumner Smith, an engineer. Touring through the districts, they gave talks on mine safety work, laying particular emphasis upon the need for first-aid training among mine workers. Jesse Henson of Wilkes-Barre, Pa., acted as instructor, training all the applicants in first-aid work. After the preliminary work had been done by this staff, The Union Pacific Coal Company helped to organize first-aid classes at Rock Springs, where the British miners, who had received their early training in ambulance work in their native country, proved to be apt students. Many of them received certificates of proficiency in first aid, while others qualified for appointments as instructors.

A First-Aid Association was formed at Rock Springs and, as the movement for training gained momentum, the group raised a substantial fund which it used in community work. In many cases, the employes were openly hostile to the innovation and it remained for a small minority of the workers to bring success to the program.

ANOTHER RECORD: Reliance No. 7 Mine bulletin board records another safety achievement as Frank Peternell, safety engineer, marks up the 1,479th day without a lost-time accident.

In 1912, the original first-aid contest in the mining field was held for the men who had been trained at Rock Springs and a gold medal, donated by the mine superintendent, was the first prize. The medal was won by No. 7 Mine, Rock Springs. The contest created such response that it was thought worthwhile to make the meeting an annual affair, and a First-Aid Field Day was arranged to be held in Rock Springs during the summer months. The winning team each year was sent to the International First-Aid and Mine-Rescue Competition. It was not long before other first-aid teams were organized at the other districts.

In 1913, the office of safety director of The Union Pacific Coal Company was created with headquarters in Rock Springs. Committees of mine workers were formed to investigate all serious accidents and to give their recommendations for safer practices. Regardless of the further enlarged program, no perceptible reduction in the number of accidents occurring in and around the mines was accomplished.

New Management Outlook

Eugene McAuliffe became president of the company in 1923 and brought with him a new outlook on the safety problem and a new firmness and energy to reduce accidents. The problem was a difficult one and the solution required time. With the able assistance of George B. Pryde and I. N. Bayless, he promptly proceeded to put his plans into effect. They felt that the way to reduce accidents was to reach the individual miner and to penetrate his lack of concern for his own safety, and they suspected the way to interest the individual miner was by means of rewards and prizes. By putting a premium on safety, no miner could afford to ignore it.

They began by awarding prizes to members of the forces in the districts which worked the greatest number of man-shifts without an accident each year. These prizes were watches which were awarded by popular vote of the men themselves. Silverware, oil paintings, and other prizes were given to the foremen making the best accident record in their mines. Pennants were also awarded for outstanding safety performance. These banners would go to the top of the flagpole and fly for a few weeks, thereafter mysteriously disappearing. In spite of all this, the same apathetic attitude continued to exist with regard to mine accidents.

Therefore, in 1931 each mine was organized into safety sections with a foreman designated as safety director in charge; each section to have a meeting once each month to discuss safety suggestions, which were called for from anyone attending. A general district safety meeting was arranged for each month where all sections attended;

STORAGE: Explosives magazines are scientifically designed and built of rock or concrete and located at correct distances (not less than 1,000 ft.) from working areas and dwellings.

a meeting of the directors of safety sections together with all superintendents and foremen was arranged for discussion. The problem appeared to be to get everyone interested and to attend a general district safety meeting, or, in other words, to get all employes to attend a meeting once each month for one hour's discussion to stimulate interest and attendance at safety meetings and to bring to their attention the benefits of safety equipment: goggles, hard hats, hard-toed shoes, etc., and to have small cuts and bruises treated and to guard against infection.

Automobiles Awarded

To each employe in those sections of the mine which had gone through the year without a lost-time accident was given a ticket or chance on a 5-passenger automobile. This stimulated interest and attendance at safety meetings.

Interest was evidenced to warrant the offer of two 5-passenger cars. Later, one 5-passenger car and the equivalent in cash, divided into nine cash prizes, were offered. In addition, cash prizes were offered monthly to be drawn for at monthly safety meetings for all mines that had no lost-time injury during the preceding month. Tickets were handed each employe at the door as he entered the hall; later, merchandise was given as floor prizes, these prizes drawn for by those attending monthly meetings. During the war years, Government bonds, equivalent to the price of a 5-passenger car, were given the winners.

After making various changes and carefully checking the results of each, The Union Pacific Coal Company today has the following program for prize drawings.

Monthly Prize Drawings

For administrative purposes, Union Pacific operations are grouped into six mining districts. A prize drawing is held in each district each month. If the district has experienced a lost-time accident, door prizes only are given. However, if the district has not had a lost-time injury, the door prizes, consisting of $50 in merchandise and varying each month, are supplemented by safety awards. For the first month without a lost-time injury, the men draw for prizes of $15, $10, and $5. If the district goes two months, the prize is a suit of clothes which also is offered every month thereafter until a lost-time accident occurs.

The door prizes promote attendance whether or not a main prize is being drawn for, and, as a result, the attendance is approximately 75 per cent. The meetings usually last about an hour and, in addition to the drawings, include a sound picture running about 20 minutes and talks on safety by the general safety engineer and at least one other official, supplemented by addresses by outside men, such as highway patrolmen.

Semiannual Prize Drawings

The semiannual prize drawings with a number of prizes have replaced earlier annual drawings for one big prize. This change from yearly to twice-yearly drawings, and from one to a number of prizes, was made to introduce variety and promote interest by broadening the possibility of winning.

Currently, one of the two drawings is held in February and the second in August. All employes without a lost-time injury are eligible to compete, and the main program is held in the Old Timers' Hall in Rock Springs. The event is broadcast, not only to the public, but to meeting halls in all six districts if bad weather or the mine-operating schedule makes attendance at Rock Springs difficult. Instead of an automobile, a trip to Alaska, or some similar grand prize, awards now consist of merchandise, such as refrigerators, deep freezers, radios, furniture, groceries, and so on. Each district is allotted a prize to draw for, which keeps people at the meetings.

As with the monthly district meetings, the semiannual affairs are more than merely prize drawings. In addition to safety messages by Union Pacific officials, an outside speaker is provided. It may be a state official, a representative of the Bureau of Mines or some

other outstanding man, and he also carries the safety theme forward.

Foreman is Safety Key

From day to day, however, supervision over safety is largely the job of the unit or other foremen. To help them, provision also is made for both variety and incentive. Unit foremen whose crews have not suffered a lost-time injury over the month are eligible to draw for separate money prizes at the monthly district safety rallies and prize drawings.

Since he is, in fact, the supervisor of safety on the job, the unit foreman is charged with the particular responsibility of welcoming new men, introducing them to their work and training them so that safety becomes automatic and they are able to function most efficiently. Also, of course, new safety rules and new production methods are imparted to all men, whether new or old, by the supervisor.

Safety work really begins with hiring and—it can be truly said—never ends. A full-time personnel director reporting to the vice president in charge of operations handles recruiting and hiring, including physical examinations for all new employes. The personnel director also handles housing and other problems that crop up in employe and family relations, in addition to his other duties in the line of compensation and medical care of injured persons.

Before actually going to work, each new employe meets with the mine superintendent, who gives him the company book of rules and discusses at some length certain company policies, such as those dealing with hard hats, shoes, and goggles. After that, the unit foreman or other supervisor takes over, except for such things as first-aid training. Courses in first aid are conducted every six months and involve 15 hours of instruction by, as a rule, men from the first-aid teams. The courses, incidentally, are conducted under the supervision of the U. S. Bureau of Mines, which furnished the original instruction to members of first-aid teams.

First Aid for All

First-aid training includes everybody —not only miners but all other workers, supervisors, and officials. Upon successful completion of the 15-hour course, employes receive certificates from the Bureau of Mines and the company. If an employe is unable to pass an examination after 15 hours of instruction, he is given special additional training until he is qualified for a certificate.

For maximum personal protection, miners are required to obtain and use goggles in addition to hard hats and safety shoes. Promotion of goggle use is an example of the unusual steps taken to effectuate a particular safety measure. When goggles were first introduced, each miner's eyes were examined and he was given—also free—goggles corrected to his vision. Free eye examinations still are given new employes—as well as older ones who request it—but the men must now provide their own goggles.

Other tried-and-true methods of promoting safety consciousness among employes include such things as bulletin boards at each mine showing the number of days the operation has been without an accident, and the publication of a monthly bulletin listing safety records by districts and reporting accidents and injuries. This monthly publication is designed for home reading and includes material, besides safety data, of interest to other members of the family as well as to the worker himself.

The Company Rule Book

On the job, the book of rules and the company book of standards provide perhaps the major hard-and-fast principles to be followed by both workers and supervisors. Other than that, the job is largely left to the supervisors and men to work out as they proceed, always remembering that "safety is the first consideration." This policy is followed as a result of experience which indicates that keeping the program informal and letting men and supervisors use their ingenuity and initiative, plus keeping interest up by varying the program, are more conducive to results than rigid formalism all the way through. The code of standards, incidentally, took nearly two years to prepare and has been revised seven times since its original publication date—July 15, 1925. Based on experience and engineering study, it provides the best possible guide to safe and efficient installation of wire, tracks, machinery and equipment, the construction of clearances, and the conduct of other mining operations.

To facilitate joint worker-supervisor effort in the field of safety, each unit foreman is considered a supervisor of safety and functions as such. The average number of men assigned to a unit foreman is eight; the maximum, sixteen. Worked out by the general safety engineer, his assistant, and the ventilation engineer, this arrangement has proved its worth in achieving the maximum in safety results.

Supervisors are kept abreast of safety developments and management policy at weekly meetings, which invariably are attended by one or more general officials. The meetings normally last an hour, and the proceedings include discussion of accidents, if any have occurred, consideration of safety inspection reports, and discussion of production problems. The supervisors also are encouraged to subscribe to and read the pertinent technical and safety publications and to study meeting papers and transactions dealing with both safety and efficient operation.

Continuous Inspection

A key factor in the Union Pacific safety program is continuous working-hour inspection of all mining operations and surface facilities. In other words, one representative of the general safety engineer inspects continuously on the day shift, and a second on the night shift. The inspectors are accompanied by mine foremen or other supervisors and, from section to section, by the respective unit foremen. Any violation of the code of standards is reported to the general manager who, in turn, passes it to the superintendent of the operation for corrective action. The safety department then checks to make sure that the corrective action was taken. Standard report forms are *not* used in safety inspection because, among other things, it was felt that they would be conducive to getting into a rut, whereas freshness and a flexible approach are the real essentials.

A Safety Fraternity

An out-of-the-ordinary additional step has done much to reinforce safety work at Union Pacific operations. That

step was the founding in 1941, with 43 charter members, of Sigma Tau Epsilon, the first Greek-letter safety honor society in the world. Membership is restricted to supervisors "who have attained a commendable standard of safety in the conduct of their work." Those eligible for membership and the qualifications are:

Mine superintendents at mines that have won the Sentinels of Safety trophy.

Mine foremen in charge of an operation that has won a Sentinels of Safety trophy, or which has completed a calendar year without a lost-time accident.

Unit foremen and outside foremen who have conducted operations for three consecutive years without a lost-time injury to men in their charge. Only unit foremen and outside foremen are eligible to vote and hold office. General officers are not eligible for membership, but any society member promoted to a general office position may retain his membership.

The society meets quarterly. Its major contribution, however, is through the operation of committees on safe practices. Ten such committees function continuously in the following fields:

Roof and rib falls and timbering.

Haulage.

Handling and use of explosives.

Handling and storage of materials inside.

Ventilation and rock dusting.

Electrical and mechanical installations.

Proper operation and maintenance of tools and machinery.

Handling and storage of materials outside.

Prevention of injuries from slipping and falling of persons.

General welfare, inside and outside.

Each committee keeps a continuous eye on its phase of the safety problem. All accidents are reviewed and discussed and, when all the evidence is in, the committees make the necessary recommendations for hazard elimination and safe operation. If accepted by the final authorities—the president and vice president in charge of operations—the recommendations go into effect.

Success from Overall Effort

Actually, what has been presented previously barely touches on the highlights of the safety program. It is notable that the company has dug deeply into its pocket for safety materials and the employment of safety engineers. Except for the war period, when the necessity for hiring large numbers of green men was a complicating factor, and for years in which major strikes or strike threats occurred, which the records show are reflected in an immediate increase in accidents during the period of disturbance, the result has been a steady accelerating rise in man-hours of exposure per accident, as shown in the accompanying chart.

Regardless of what type of safety program a company may have, the success of that program depends mainly on the persistent overall effort of each and every member of the company. That is the foundation stone of The Union Pacific Coal Company's entire safety program.

Prepared for management staff discussion is a complete annual summary of each lost-time accident suffered by The Union Pacific Coal Company employes. This report, carefully scrutinized by officials, is an important part of the safety program that has one objective—the complete elimination of mining accidents.

THE UNION PACIFIC COAL COMPANY SAFETY PERFORMANCE 1951

	ROCK SPRINGS NO. 8	RELIANCE NO. 1-11	RELIANCE NO. 7	STANSBURY NOS. 1 & 7½	STANSBURY NO. 3	WINTON NOS. 1 & 7½	SUPERIOR NOS. 7 & 7½	D. O. CLARK NOS. 9 & 15	HANNA NO. 4-A	TOTAL
Entry Number	05826	05824	05833	11151	14732	05832	05831	14733	05779	
Man-Hours Worked in 1951	187,274	481,617	464,666	448,011	437,869	326,457	658,123	330,981	561,590	3,896,588
Employes per Shift on Surface	35	36	35	44	35	33	46	22	79	385
Employes per Shift Underground	55	233	221	222	224	159	310	144	254	1,822
Length of Shift on Surface (Hours)	7¾	7¾	7¾	7¾	7¾	7¾	7¾	7¾	7¾	7¾
Length of Shift Underground (Hours)	8	8	8	8	8	8	8	8	8	8
Did Plant Operate 1, 2, or 3 Shifts Daily?	1	2	2	2	2	1	2	2	2	
Number of Days Plant Worked in 1951	220	213.50	213	215.25	215.25	209.50	209.75	209.75	205	
FATAL ACCIDENTS	0	0	0	0	0	0	1	0	2	3
Days Lost (6,000 Each)	0	0	0	0	0	0	6,000	0	12,000	18,000
Permanent Partial Disabilities	1	4	0	2	3	0	2	0	0	12
Days Lost	750	7,950	0	1,350	6,750	0	5,100	0	0	21,900
Temporary Lost-Time Injuries	1	1	0	1	1	1	3	1	0	9
Days Lost	69	122	0	47	135	77	244	96	0	790
Total Number Injuries	2	5	0	3	4	1	6	1	2	24
Days Lost	819	8,072	0	1,397	6,885	77	11,344	96	12,000	40,690
Frequency Rate per Million Man-Hours	10.68	10.38	0	6.70	9.14	3.06	9.12	3.02	3.56	6.16
Severity Rate per Thousand Man-Hours	4.37	16.76	0	3.12	15.72	.24	17.24	.29	21.37	10.44

SAFETY CONFERENCE: Safety begins with the staff at Union Pacific. A staff conference in the main office at Rock Springs, headed by V. O. Murray, vice president, discusses the week's safety events. Left to right: H. M. Tibbs, personnel manager; E. R. Jefferis, manager of stores; J. D. Foster, assistant treasurer; E. T. Baldridge, auditor; John B. Hughes, general manager; V. O. Murray, vice president, operations; F. J. Peternell, safety engineer; Charles Grosso, general superintendent; A. L. Hansen, chief clerk; K. E. Darling, general manager, Southern Wyoming Utilities Company; I. M. Charles, chief engineer.

PART IV

HOW ACCIDENT REPORTS ARE HANDLED

THE day-by-day nature of Union Pacific's safety program is evidenced by the use of "Form 266," illustrated. This report is made in triplicate, and must be made in all cases of accidental injury in and around the mines, regardless of the seriousness of the injury or resultant disability. It is the most referred to form in the company's mining organization.

The report must be made out immediately by the supervisor in the area where the injury occurs, and the original goes to the superintendent who checks for completeness and forwards the slip to the general manager. Thus, the injury becomes a top-management affair.

The second, or blue, copy goes to the safety engineer and is retained by him until the employe returns to work. In the meantime, the safety engineer

FORM 266

ORIGINAL Book No. 903 Report No. 10

Mine #1 District WINTON Wyo. JUNE 1 19 52

Section No. Check No. 185 Occupation MACH. RUNNER

Name JOE BLANK was injured today in the following manner STRUCK ON FOOT BY FALLING CAP PIECE

Nature of injury BRUISED FOOT

Reporting Official will designate, by check mark below, treatment and disposition of the above injured workman, forwarding this original, at once, to the General Manager at Rock Springs.

☒ First Aid, Continued at work ☐ First Aid, Walked home

☐ Ambulance to home ☐ Ambulance to hospital

2:40 P.M.

Signed John Smith

Section Foreman or Department Foreman

FIGURE 18: Facsimile of Form 266 which is used successfully to keep track of personal injuries at U.P. mines.

What's the safety score at the end of the year? In capsule form, this is the final record as tabulated from daily reports. Note that in 1951, Reliance No. 7 operated the entire year with a perfect safety record. Everything must work just right to achieve such a record, but that doesn't stop Union Pacific Coal from continuing its efforts to operate accident-free.

THE UNION PACIFIC COAL COMPANY LIST OF INJURIES 1951

Name	Date Injured 1951	Cause	Date Disability Began 1951	Date Ability to Resume Work	Calendar Days Actual	Calendar Days Weighted
ROCK SPRINGS NO. 8 MINE — ENTRY NO. 05826						
Employe "A"	Aug. 20	Caught hand between rope and corner of car.	Aug. 21	Dec. 13, 1951	114	750
Employe "B"	July 30	Right hand caught between mining machine and prop.	July 31	Oct. 8, 1951	69	69
RELIANCE NO. 7 MINE — ENTRY NO. 05833						
No lost-time accidents during 1951						
RELIANCE NO. 1 MINE, NO. 11 SEAM — ENTRY NO. 05824						
Employe "C"	Feb. 22	Fall of face coal.	Feb. 23	June 5, 1951	102	300
Employe "D"	Mar. 8	Fall of rib coal which knocked him into running panline.	Mar. 9	Sept. 11, 1951	186	3000
Employe "E"	Nov. 23	Right arm struck by drill machine.	Nov. 24	Mar. 25, 1952*	122	122
Employe "F"	Dec. 4	Squeezed between loading head pan and guard on locomotive cab seat.	Dec. 5	July 1, 1952*	209	4500
Employe "G"	Sept. 18	Fall of top coal and rock.	Sept. 19	Dec. 31, 1951	103	150
STANSBURY NOS. 1 & 7½ SEAMS — ENTRY NO. 11151						
Employe "H"	July 31	Caught left hand between ratchet pan rail and jackpipe.	Aug. 1	Dec. 3, 1951	124	160
Employe "I"	July 31	Squeezed between prop set on the low side and loaded trip.	Aug. 1	Feb. 1, 1952*	184	1200
Employe "J"	June 8	Strained himself pulling rail.	June 9	July 26, 1951	47	47
STANSBURY NO. 3 SEAM — ENTRY NO. 14732						
Employe "K"	Feb. 15	Coal hit foot, causing him to fall and strike left knee against gouge pan.	Feb. 16	Nov. 19, 1951	276	1800
Employe "L"	Nov. 6	Fall of rock.	Nov. 7	Sept. 1, 1952*	299	4500
Employe "M"	Aug. 30	Struck on left foot by auger.	Aug. 31	Nov. 14, 1951	75	450
Employe "N"	July 13	Struck on right shoulder by crossbar and thrown over locomotive cab guard.	July 14	Nov. 26, 1951	135	135
WINTON NOS. 1 & 7½ MINES — ENTRY NO. 05832						
Employe "O"	Nov. 29	Left leg struck by flying coal.	Nov. 30	Feb. 15, 1952*	77	77
SUPERIOR D. O. CLARK NOS. 7 & 7½ SEAMS — ENTRY NO. 05831						
Employe "P"	Nov. 12	Struck on right side by ratchet handle.	Nov. 13	Jan. 3, 1952	51	51
Employe "Q"	Jan. 20	Fell from nipper's seat on locomotive and caught arm between wheels of mining machine truck and rail.	Jan. 21	Feb. 26, 1951	36	3600
Employe "R"	Jan. 12	Caught between end of door and locomotive.	Jan. 13	Dec. 29, 1951	350	1600
Employe "S"	June 14	Struck with flying jackpipe.	June 15	Aug. 20, 1951	66	66
Employe "T"	Feb. 1	Fall of rock.	FATAL	FATAL	6000	6000
Employe "U"	Sept. 4	Squeezed between conveyor and timber.	Sept. 5	Jan. 10, 1952	127	127
SUPERIOR D. O. CLARK NOS. 9 & 15 SEAMS — ENTRY NO. 14733						
Employe "V"	Feb. 27	Caught his foot on motor and was dragged.	Feb. 28	June 4, 1951	96	96
HANNA NO. 4-A MINE — ENTRY NO. 05779						
Employe "W"	June 11	Fall of top coal.	FATAL	FATAL	6000	6000
Employe "X"	Jan. 3	Fall of rib coal.	FATAL	FATAL	6000	6000

*Estimated

investigates the accident personally. The third, or pink, copy is a permanent part of the superintendent's files.

This is the machinery of Form 266, but that's only part of the story. Management studies the accident, and takes steps to prevent recurrences. The vice president makes available a complete study of the accident and remedial measures to each member of the supervisory staff. Finally, the subject is further discussed at staff meetings to make certain that every effort is made to find out the cause of the accident and to prevent another one like it.

At the end of each month, all accidents are summarized by districts and mines; then a complete summary is made showing details of every lost-time or fatal injury. As long as there are accident-prone people, there will be accidents, but U.P. does everything possible in an organizational way to keep injuries to a minimum.

On page 96 is a composite report of The Union Pacific Coal Company accidents of 1951. Study it thoroughly, with the thought that this is the way management studies the yearly summary of accidents.

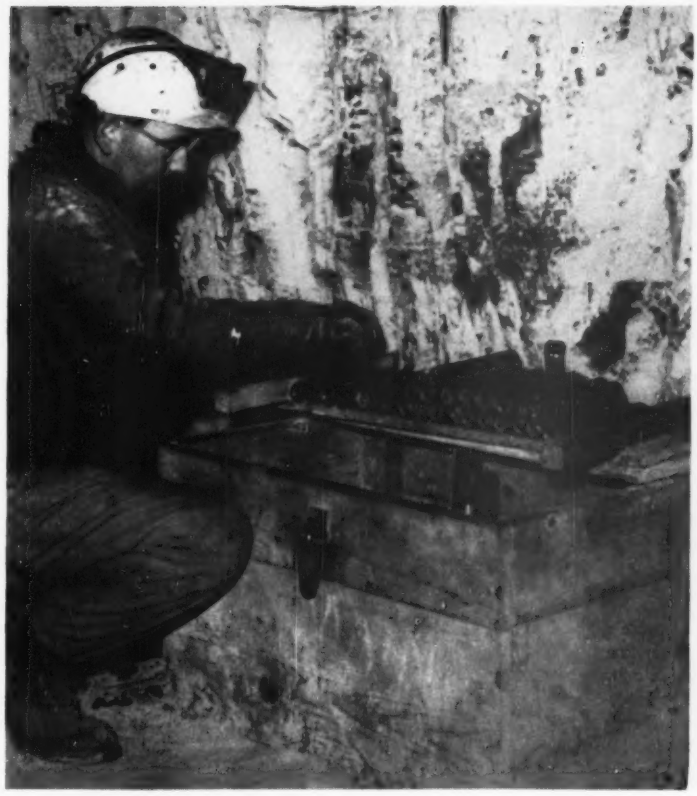
Every accident is brought out into the open. The date, date of recovery, type of accident, penalty, and other pertinent facts are listed in detail. It is the belief of the editors that this is the first time a complete safety report of this scope has ever been released for publication.

Desire for Safety

All the accident records in the world would mean nothing unless there was a desire on the part of management to accept its responsibility for safety.

An examination of reports such as those illustrated in this section shows outward evidence that management in The Union Pacific Coal Company has accepted this responsibility. Thus, the safety program reaches every part of the plant. At all meetings pertaining to safety, members of top management are present. Above all, men in a supervisory capacity are so instilled with the necessity of accident prevention that an excellent safety pattern is set.

It is obvious with The Union Pacific Coal Company that the fundamental principle of a sound program is the desire of management to want safety.



CARE IN EXPLOSIVES: Underground storage boxes, containing no more than a day's supply of explosives, are correctly placed in accordance with proper rules and regulations in all Union Pacific mines.

PART V

USE AND HANDLING OF EXPLOSIVES

The following rules and regulations pertaining to the handling and use of explosives are contained in the "Code of Standards" Handbook prepared for The Union Pacific Coal Company employes. The rules are sound and based on good safety practices as applied to the operations of The Union Pacific Coal Company. It must be understood that the rules and regulations are not published as standard procedure for other mining operations; rather, their value is to help guide others in preparing their own specific rules and regulations.

1. All powder must be stored in well-constructed rock or concrete magazines on the outside, the location of which shall not be less than 1,000 ft. from any dwelling house.

2. Detonators must be stored in separate, well-constructed, fireproof buildings, not less than 50 ft. from a powder storage magazine.

3. All powder shall be taken into the mine in a specially constructed powder car, of standard design. This car shall be made of wood, and shall be of double-box construction, the

MODERN TIPPLE: The Stansbury tipple is another example of modern mine operating practices at The Union Pacific Coal Company.

inner box of which shall be insulated from the outer box carrying the framework and running gear by having all nail heads, bolts, etc., countersunk to eliminate all possible contact to ground.

4. Whenever powder is not taken underground immediately upon delivery at the mouth of the mine from the outside storage magazine, it shall be placed in a well-constructed, locked, fireproof magazine which shall not be closer than 150 ft. to the mouth of the mine or to any point at which a man trip loads or discharges. The powder shall remain in this magazine until loaded into the powder transportation car for delivery within the mine.

5. Powder shall be taken into the mine at the end of, or between, shifts and at a time when there are the fewest possible men at work within the mine. In no instance shall powder be taken into the mine when a regular shift of men, other than the third or eleven o'clock (commonly called the "graveyard") shift is at work.

6. Powder shall be taken into the mine in the original unopened boxes as received from the manufacturer and handled by the railroad companies. Broken boxes, or boxes that have been opened, must not be handled in the regular manner as herein specified, but shall be handled separately, and by hand, from the outside storage magazine to the several units and working places.

7. In transporting powder within the mine on long, level hauls, same may be transported in approved standard powder car attached behind the locomotive.

8. When powder is being transported on motor runs, all other haulage on these entries or motor runs must be stopped and remain inactive from the time the powder transportation begins until it has reached its destination. The mines superintendent shall designate some responsible employe to supervise personally the movement of the powder car.

9. Powder shall be taken directly to centrally located distribution stations within the mine, from which points it shall be distributed to the various units and working places. Only sufficient powder for one day's work shall be taken into the mine at any one time, and no powder shall be allowed to accumulate or remain in the underground distribution stations.

10. Underground distribution stations shall be made in the solid coal at least 300 ft. from the main slope and 50 ft. from any traveling way or intake airway, and shall be provided with a strong door that shall be kept securely locked except when entered by a person or persons so authorized. Distribution stations must be fire resisting, with end walls of tile or metal lath-and-plaster construction.

11. Not over 200 pounds of explosives, including any surplus remaining from the previous day, shall be placed in any one distribution station.

12. Once each shift all empty boxes, paper, sawdust, etc., must be gathered and sent from the mine. No accumulation of debris will be permitted in or around the distribution station.

13. Distribution by the powderman from the underground station to unit powder boxes shall be made in standard, electrically nonconducting canvas bags similar to those sold by the powder manufacturers.

14. Unit powder boxes shall be of uniform size. Boxes shall be made with a dividing partition so that the fresh supply of explosives can be placed apart, thus permitting the use of the older stock first.

15. At each unit powder box there shall be a stamp, and as powder is delivered to the box by the powderman each stick must be stamped in such a manner as to be identified easily if found in other than its proper place. Stamps shall be inspected regularly to see that they leave a legible mark on each stick.

16. Each unit powder box shall be plainly marked on the outside showing the unit number and the maximum number of sticks of powder that the box may contain.

17. Distribution stations underground shall be located and territory so allotted that a powderman will not have more units to serve than can be visited once each shift with a powder delivery.

18. Except in emergencies, the powderman shall be an employe other than the employe assigned to the delivery of detonators.

19. In no case shall powder be made up at the working face. Powder shall be made up at the powder box and only the amount to be used taken to the face. If, for any reason, more powder is taken to the face than is required for the round of shots, the excess powder must be taken back to the storage box before the round of shots is fired.

20. Not more than 1½ lbs. of powder shall be used in any one hole.

21. All detonators must be carried from the storage place outside the

mine to the inside in standard leather containers which shall be painted yellow.

22. All detonators stored inside the mine shall be in a suitable receptacle, not closer than 50 ft. to the powder storage boxes.

23. In no case shall loose detonators be taken to the working face.

24. In the event that any detonators are lost, the foreman in charge shall be notified immediately.

Blasting Precautions

1. Permissible powder is *only* "permissible" when the proper amounts are used. Use only 1½ lbs. of permissible explosives in any one hole.

2. Never force a cartridge into a hole.

3. To slit the cartridge and tamp tight is detrimental to the cushioning effect desired in blasting coal. This practice is prohibited.

4. Wooden bars are provided for tamping holes. The use of iron tamping bars is prohibited.

5. Use precautions in seeking the cause of a missed shot.

6. To drill, bore, or pick out a charge which has failed to explode, is prohibited. Either drill and charge another borehole at a safe distance (not less than 2 ft.) from the missed hole, or, better still, wash out the missed charge with water from the hose of your sprinkling line.

7. Use only the proper containers as provided for in transporting or carrying blasting caps.

8. Never try to withdraw the wires from an electric blasting cap.

9. Always store electric blasting caps or blasting machines in a dry place.

10. The leading wires attached to the blasting machine are to be disconnected and shunted immediately if it becomes necessary to return to the shot.

11. When blasting is done electrically and a missed shot occurs, a five-minute interval should elapse before returning to the shot.

12. Never return to any shot which has failed to explode without first disconnecting the shooting cable from the blasting machine, and short circuiting the wires of the shooting cable.

13. Good wire connections are not secured when looped or tied. Scrape the ends of the wires clean and bright, and twist them tightly together.

14. Always see that bared ends of electric detonator lead wires are twisted together or shunted and keep them so until just before firing, then untwist them and connect with firing lines.

15. Leading wires are not to be dragged around. Always coil them and carry them.

16. Suspend shooting cable on timber, being careful to see that cable is not in contact with signal lines, pan-lines, power lines, or track.

17. Insert electric blasting cap in cartridge carefully. Have closed end of detonator pointing towards the bulk of the explosives.

18. Storing or transporting electric blasting caps with any type of explosive is prohibited.

19. Old or broken lead wires or connecting wires are not to be used.

20. Blasting machines are to be kept clean and dry. They are built to operate with full force; twist the handles vigorously, not halfheartedly.

21. Shooting from the trolley wire or feeder line is prohibited.

22. Making up shots at the working face is prohibited.

23. Excess powder or detonators are to be returned to their proper storage places before shooting.

24. Be sure that you have proper shelter before shooting.

25. Always warn men that are in close proximity of blasting areas. See that all approaches are safely guarded and the word "Fire" is shouted three (3) times before shooting.

26. The shooting of dependent shots is prohibited.

OLD TIMERS': Old Timers' Building is the center of company outside activities at Rock Springs. In front is the famous "Charlie Smith," the first locomotive used in the mechanized mining program.

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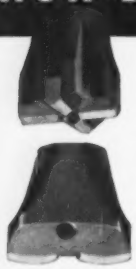

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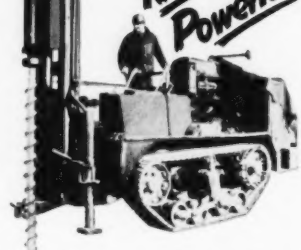

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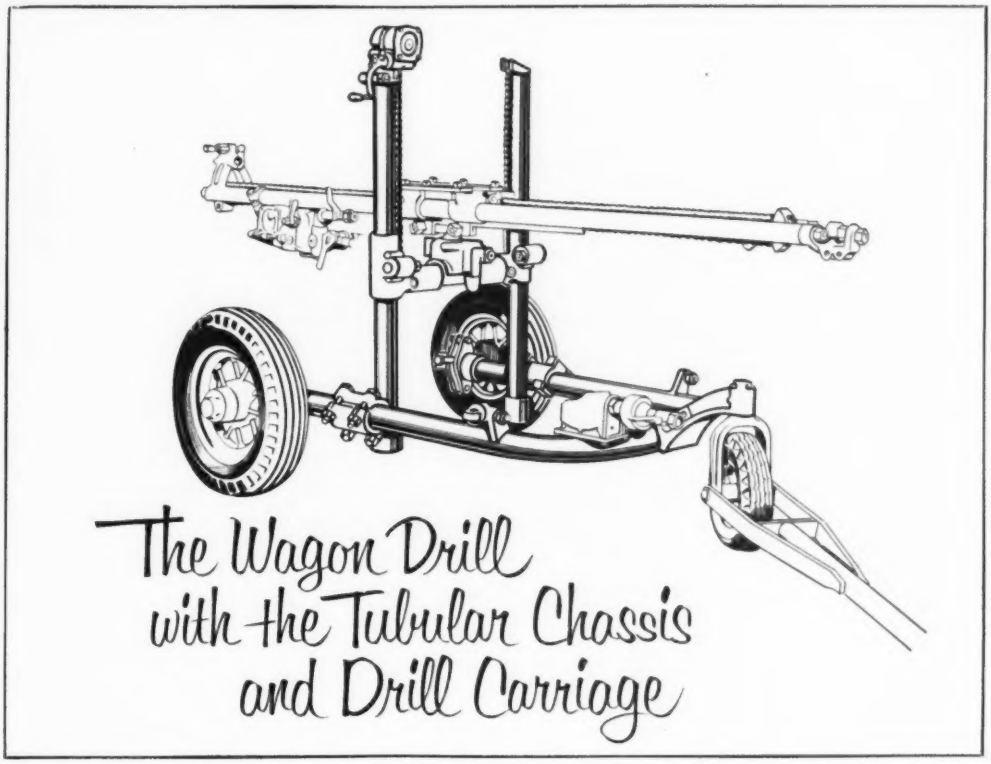

The Wagon Drill with the Tubular Chassis and Drill Carriage

G-300 Wagon Drill

The rugged tubular chassis and drill carriage of the G-300 WAGON DRILL provides rigidity and strength without unnecessary weight.

The tubular "H" structure that supports the drill carriage gives greater stability than the conventional design and minimizes vibration. The all-around sturdy construction of the G-300 maintains correct alignment at all times, insuring maximum drilling efficiency with minimum upkeep.

G-300 Wagon Drill

- is designed to take full advantage of the high drilling speed and strong rotation of the CP 4-inch 70-N Drifter.
- has controls conveniently centralized.
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- has a heavy-duty centralizer.
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Operates on sloping ground — as well as on the level.

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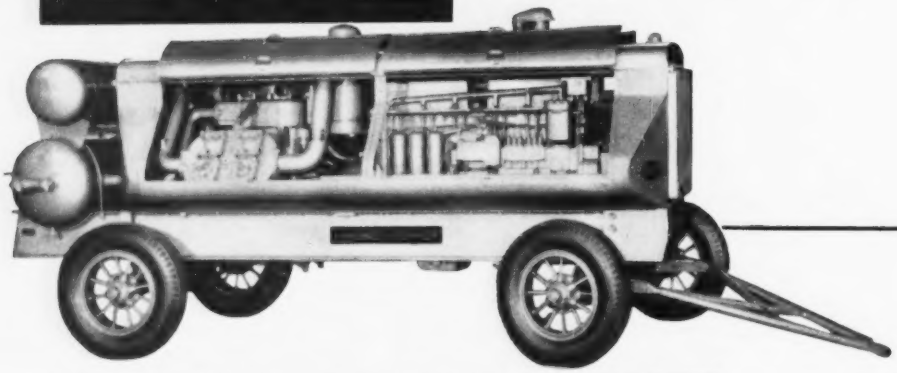
And don't forget — to compare fuel consumption, too.



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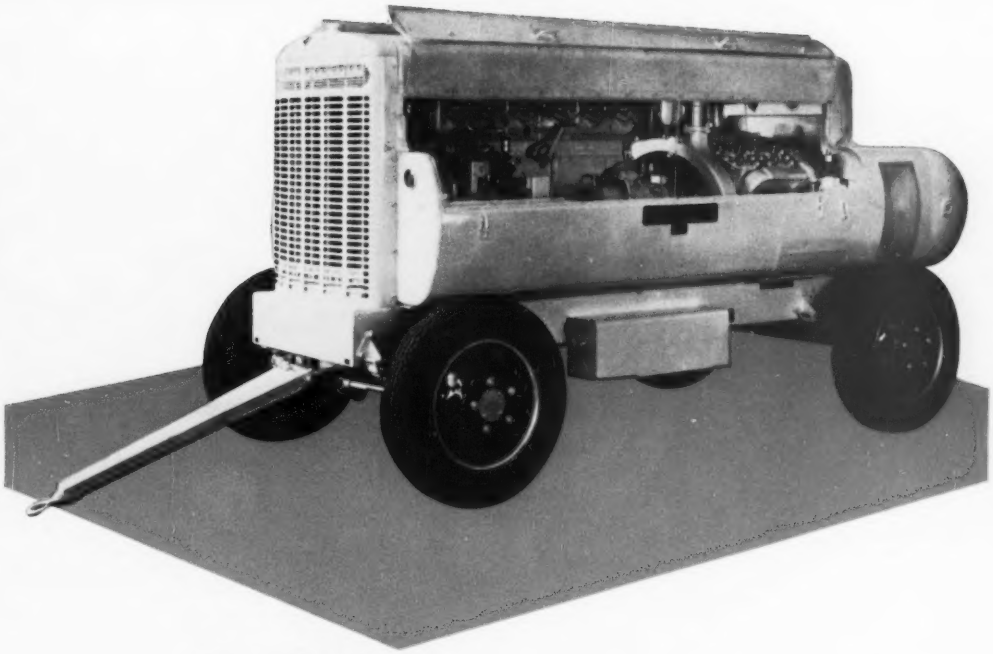

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Really portable—smaller than other units of like capacity—produces 630 CFM of air power—runs two 4" wagon drills simultaneously at top efficiency

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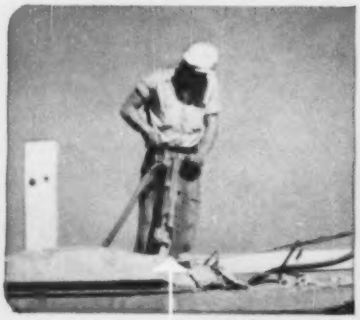
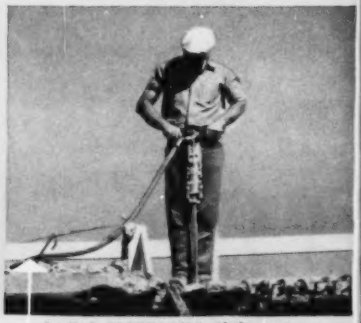


Le Roi-CLEVELAND Breakers and Spades pack plenty of punch for speedy work in the hardest concrete or stiffest clay. Protective air-cushion in front end assures long life. Well balanced for easy handling. That's why operators like them — do more work with them. Sizes, 18 to 80 lbs.



Le Roi-CLEVELAND Sinkers have strong rotation, powerful blow from snappy valve action. Drill more inches per minute. Easy to hold, kickback is reduced. Operators get less tired, drill more feet per shift. Sizes, 17 to 82 lbs., including the popular H10 and H111.

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YOU'RE money ahead, when you hook up Le Roi-CLEVELAND Air Tools to a Le Roi Airmaster Compressor. They *work together*, to put more profits in your pockets!

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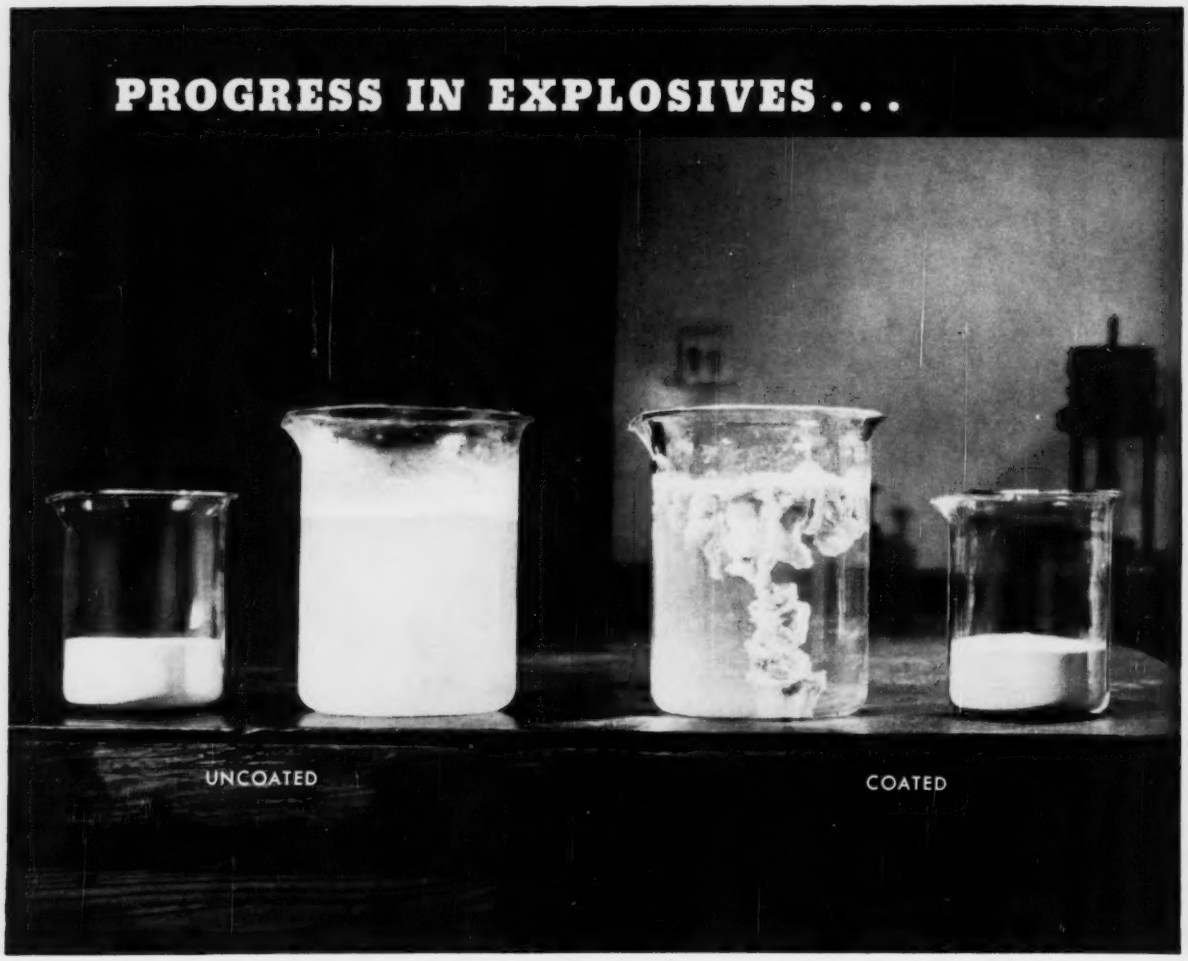

WHICH BEAKER HAD THE BANG?

The small beaker (left) contains ammonium nitrate. This is an important explosives ingredient, but it absorbs moisture readily. Notice in the large beaker (left)—how it dissolves immediately in water.

The small beaker (right) contains *Hercules* ammonium nitrate *treated with a special resin*. In the large beaker (right) note how the resin-treated ammonium nitrate repels water without affecting explosives' properties.

Here is a simple example of Hercules' pioneering that gives you better blasting efficiency under adverse storage and climatic conditions both in manufacture and in field use.

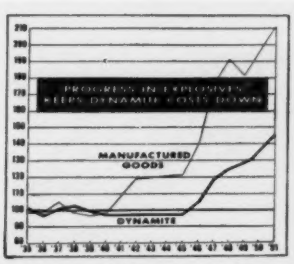

Chart shows relative stability of dynamite prices since 1935, as compared with prices of other manufactured goods. 1935-39 values=100.

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